THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY, ETC, ETC.

"Nec aranearum ſane textus ideo melior, quia ex ſe fila gignunt. Nec noſter vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

VOL. XIV.

LONDON:

PRINTED FOR ALEXANDER TILLOCH;

And Sold by Meſſrs. RICHARDSON, Cornhill; CADELL and DAVIES, Strand; LONGMAN and REES, Pater-noſter Row; DEBRETT, Piccadilly; MURRAY and HIGHLEY, No. 32, Fleet-ſtreet; SYMONDS, Pater-noſter Row; BELL, No. 148, Oxford-ſtreet; VERNOR and HOOD, Poultry; HARDING, No. 36, St. James's-ſtreet; BELL and BRADFUTE, Edinburgh; BRASH and REID, Glaſgow; and W. GILBERT, Dublin.

[*Taylor and Wilks, Printers, Chancery-Lane.*]

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OF THE
FOURTEENTH VOLUME.

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THE

PHILOSOPHICAL MAGAZINE.

I. *A Reply to Mr.* Playfair's *Reflections on Mr.* Kirwan's *Refutation of the Huttonian Theory of the Earth. By* Richard Kirwan, *Esq. LL. D. F. R. S. and P. R. I. A.*

DEAR SIR, Dublin, Aug. 24, 1802.

When I first undertook to state some objections to Dr. Hutton's Theory, I little imagined I should call forth such indignation and such illiberal personalities as appeared in the second edition of that work; but however hurt the self-love of an author might have been by an attack on his favourite ideas, I had still less reason to foresee that the same style of hostility would have been persisted in by any person to whom I had given no offence whatsoever. Mr. Playfair's Illustrations of the Huttonian Theory, which I have seen only a few days ago, convince me I was mistaken; he not only attempts to justify the *asperities*, as he calls them, of Dr. Hutton, but aggravates them by new invectives. You need not fear, Sir, that I shall pollute the pages of your journal by the vulgar mode of retaliation; I shall make no reflections on his defence of Dr. Hutton's Theory: enough has been said on that subject. I shall content myself with repelling his unprovoked and unmerited attacks on myself.

To effect this, however, I shall be obliged to state his abusive paragraphs, and thus expose their indecency. It is the only vengeance I shall take; he, probably, will account it none.

Page 119. "To assert, that in the economy of the world we see no mark either of a beginning or an end, is very different from affirming, that the world had no beginning, and will have no end. The first is a conclusion justified by common sense as well as sound philosophy; while the second is a presumptuous and unwarrantable assertion." Here I must deny that the first assertion, namely, that we see no mark of a beginning, is a conclusion justified by common sense and sound philosophy.

Mr. De Luc, Sauſſure, and Dolomieu, were not deficient either in common ſenſe or ſound philoſophy, yet they all aſſert that we may diſcover evident marks of the beginning of the world in its preſent ſtate: nay, Dr. Hutton himſelf allows it, for he judged the actual world to have proceeded from a preceding, and aſſerts that it will have an end. What Mr. Playfair muſt then mean is, that we can ſee no trace of the beginning of this ſucceſſion of worlds. Of ſuch ſucceſſion, it is true, we can trace no beginning, becauſe it is merely fictitious: but while Dr. Hutton aſſerted the reality of ſuch a ſucceſſion without aſſigning any limit, it was natural for me, who was totally unacquainted with him, to infer that he really judged it to have no beginning: this concluſion was ſo natural, that it occurred to others long before I had written on this ſubject. Mr. Williams, his countryman, who was probably acquainted with him, ſays, "That Dr. Hutton aims at eſtabliſhing the belief of the eternity of the world, is evident from the whole drift of his ſyſtem, and from his own words; for he concludes his ſingular Theory with theſe ſingular expreſſions: 'Having in the natural hiſtory of the earth ſeen a ſucceſſion of worlds, we may from this conclude that there is a ſyſtem in nature—in like manner as, from ſeeing the revolutions of the planets, it is concluded that there is a ſyſtem by which they are intended to continue theſe revolutions. But, if the ſucceſſion of worlds is eſtabliſhed in the ſyſtem of nature, it is in vain to look for any thing higher in the origin of the earth. The reſult, therefore, of our preſent inquiry is, that we find no veſtige of a beginning, no proſpect of an end.'"—Williams's Natural Hiſtory of the Mineral Kingdom, Preface, lx.

Now, I aſk what can be the meaning of theſe laſt words, *it is in vain to look for any thing higher in the origin of the earth.* Higher than what? Is it not plain that the meaning is, *higher* than that eſtabliſhed ſucceſſion, of which ſucceſſion we can trace no beginning? And what is a ſucceſſion of which we can trace, and to which we aſſign, no beginning? Now Dr. Hutton, in his firſt edition, no where mentioned that it had a beginning, though ſuch beginning were not apparent on *bare* inſpection of the actual world; was not then his meaning at leaſt ambiguous?

So alſo Mr. Howard, in his learned work on the Structure of the Earth, p. 549, ſays: "Dr. Hutton rejects all time, the operations of his living renovating nature ſcorn all limits: time (ſays he), which meaſures every thing, is to nature endleſs and nothing." But to return to Mr. Playfair: "Mr. Kirwan, in bringing forward this raſh and ill-founded cenſure,

censure, was neither animated by the spirit nor guided by the maxims of true philosophy. By the spirit of philosophy he must have been induced to reflect, that such *poisoned* weapons as he was preparing to use are hardly ever allowable in scientific contest, as having a less direct tendency to overthrow the system than to hurt the person of an adversary, and to wound, perhaps incurably, his mind, his reputation, or his peace." This severe censure appears to me unmerited: of its liberality I leave others to judge. The mention of preparation of *poisoned* weapons is perfectly risible, when it is considered that the whole argument is comprehended in ten or twelve lines. If Dr. Hutton had lived either in Spain or Portugal, some hurt to his person might indeed be apprehended; but in Britain, where Mr. Hume, with impunity, trespassed much more on the received religious principles, no danger could rationally be suspected; and it were idle to think that the reputation of an author could any more be wounded by an inference obviously deducible from his principles, than by his own statement of those principles.

Mr. Playfair continues: "By the maxims of philosophy he (Mr. Kirwan) must have been reminded, that in no part of the history of nature has any mark been discovered either of the beginning or end of the present *order*." This I deny, in common with those eminent geologists already mentioned: clear traces of a *beginning* are found. "By attending to these considerations Mr. Kirwan would have avoided a very illiberal and ungenerous proceeding; and, however he might have differed from Dr. Hutton as to the *truth* of his opinions, he would not have censured their tendency with such rash and unjustifiable severity." I never once considered the tendency of his opinions, but merely their direct consequences; I had nothing to do with their tendency in a mere geological treatise.

Page 143. "It has been asserted that Dr. Hutton maintained all calcareous matter to be originally of animal formation: this position, however, is so far from being laid down by Dr. Hutton, that it belongs to an inquiry which he carefully avoided to enter on."

Page 147. "It is nevertheless true, that Dr. Hutton sometimes expressed himself as if he thought that the present calcareous rocks are *all composed of animal remains*: this conclusion, however, is more general than the facts warrant, and, from some incorrectness or ambiguity of language, is certainly more general than he intended." Yet, p. 156, treating of my account of the origin of coal mines, he says,

"It is indeed worth while to compare what is faid concerning the degradation of mountains in the above quotations (from my Geological Effays) with what is advanced concerning their indeftructibility in another paffage of the fame volume, namely, all mountains are not fubject to decay; for inftance, fcarce any of thofe that confift of red granite, &c. One can be at no lofs about eftimating the value of a fyftem in which fuch grofs inconfiftencies make a neceffary part." Mr. Playfair then finds a grofs inconfiftency in maintaining that *fome* mountains are fubject to decay, though *all* mountains are not; facts proved beyond the reach of contradiction; but he can fee none in his own two paragraphs.

Page 157. "The quantity of hornblende and filiceous fchiftus neceffary to be decompofed in order to produce the coal ftrata prefently exifting, is enormous. It is true that Mr. Kirwan, never at all embarraffed about preferving a fimilitude between nature as fhe now is, and as fhe was heretofore, lays it down, that the part of the primeval mountains, which is worn away, contained much more carbon than the part which is left behind: this, however, is an arbitrary fuppofition." Not quite arbitrary neither. Mountains before the flood muft have been in many refpects differently circumftanced from the prefent; and if at prefent, after attaining their utmoft ftate of confolidation, many of them are in a ftate of decay, much more liable to it muft they have been then. Hornblende and filiceous fchifti are not the only ftones that contain carbon, nor are the mountains that prefent thefe rocks the only mountains that contain veins of it: many granite mountains alfo prefent them. Mr. Playfair, indeed, pays little regard to the authorities I adduce to prove the facts I allege; more impartial readers may poffibly pay more.

I fhall therefore quote one entitled to the higheft credit. Citizen Haüy, in the third volume of his Mineralogy, p. 308 and 309, tells us that anthracite (native mineral carbon loaded with ftony matter) belongs exclufively to primitive countries, and that the obfervations of Mr. Dolomieu prove the exiftence of carbon independently of animals and vegetables; and that anthracite was, he prefumed, nothing more than pure carbon, affociated, by accidental caufes, with a certain quantity of iron and filex. And Mr. Duhamel has fhown in a memoir, approved by the Academy of Sciences, that the argillaceous *ftrata* that intercede beds of coal are formed of the *detritcs* of the neighbouring mountains: *Journal des Mines*, viii. p. 40; and Haüy, iii. p. 319. My fyftem is not then quite

quite *original*, in the sarcastic sense in which Mr. Playfair applies this word; but it is evident irritation was his sole purpose.

Mr. Playfair adds, "We may also object to Mr. Kirwan, that the siliceous part of the mountain has not been chemically dissolved; it has only been abraded and worn away. Mechanical action has reduced the quartz to gravel and sand, but has not produced on it any chemical change; the carbon, therefore, could not be set loose." Mr. Kirwan has not assumed, that carbon was set loose from quartz, though it might have been from siliceous schisti and other compound stones and rocks: disintegration is often effected by decomposition; thus felspar is converted into argil and siliceous particles in many instances; but this more frequently happens to stones that contain iron.

Page 158. Mr. Playfair, objecting to strata formed by *transudation*, asks what occupied the space of the coal bed before the transudation from the upper part of the mountains. The question is unfair, and very similar to the numerous difficulties objected to Dr. Black's discovery of fixed air, before its truth was generally acknowledged. A fact is often discovered, though the mode of its production be unknown; yet in this case the question is easily answered: the carbonic part of the coal in the mountain of St. George's here alluded to was formed before the upper part of the mountain was formed; it is only the bituminous ingredient that subsequently transuded from the supervenient superior strata; and I suppose it will be admitted that petrol might penetrate and coalesce with the carbonaceous part, without floating the upper part of the mountain, as Mr. Playfair ludicrously supposes. This account is so much the more probable, as this mountain is formed of a mixed calcareous stone abounding in argil; and this species of calcareous stone is of secondary formation, as Mr. Hassenfraz, the author of this memoir, truly remarks, p. 266.

Mr. Playfair concludes by remarking, "that such reasoning is so great a trespass on every principle of common sense, that to bestow any time on the refutation of it, is, in some measure, to fall under the same censure."

Page 171. "If any one asserts, as Mr. De Luc has done, that sand is a chemical deposit, a certain mode of crystallization which quartz sometimes assumes, let him draw the line which separates sand from gravel; and let him explain why quartz in the form of sand is not found in mineral veins, in granite, nor in basalt; that is, in none of the situations where the appearances of crystallization are most general and best ascertained." What is meant by a *chemical deposit*, I do not

underſtand; but that ſand is ſometimes found regularly cryſtallized is evident, for a whole ſtratum of ſuch ſand has been found at Neuilly: to expect that a ſubſtance expoſed to endleſs friction ſhould always be found in regular cryſtals would be extravagant; that of Neuilly was therefore formed on the ſpot in which it was found.—A vein filled with ſand has been found among the mines of Peregruba in Siberia. Renovantz, Preface, xiii. Gravel and ſand differ only in ſize, and to expect either in granite rocks would be inconſiſtent; but on and beſide granitic mountains gravel very frequently occurs. The cryſtallization of baſalts is ſo far from being aſcertained, that, on the contrary, it has been demonſtrably proved that baſaltic priſms are not cryſtallized, by thoſe that have paid moſt attention to this ſubject.—Romé de Liſle, i. p. 439; Haüy Miner. iv. 476.

Page 180. "The Neptuniſt, who has provided the means of diſſolving the materials of the ſtrata, has only performed half his work, and muſt find it a taſk of equal difficulty to force this powerful menſtruum to part with its ſolution. Mr. Kirwan, aware, in ſome degree, of this difficulty, has attempted to obviate it in a very ſingular way. Firſt, he aſcribes the ſolution of all ſubſtances in water, or in what he calls the *chaotic fluid*, to their being created in a ſtate of the moſt minute diviſion. Next, as to the depoſition, the ſolvent being, as he acknowledges, very inſufficient in quantity, the precipitation took place (he ſays) on that account the more rapidly. If he means by this to ſay, that a precipitation without ſolution would take place the ſooner, the more inadequate the menſtruum was to diſſolve the whole, the propoſition may be true; but it will be of no uſe to explain the cryſtallization of minerals (the very object he had in view), becauſe to cryſtallization it is not a bare ſubſidence of particles ſuſpended in a fluid, but it is a paſſage from chemical ſolution to non-ſolution or inſolubility that is required."

My meaning is clearly ſtated in pages 10 and 11 of my Geological Eſſays, that the ſolids contained in the chaotic fluid were not diſſolved by that fluid, but were contained in that ſtate of minute diviſion to which, if the fluid could of itſelf diſſolve them, they would be reduced; and that, if the quantity of that fluid were inſufficient to hold them in ſolution, this circumſtance would haſten their cryſtallization, precipitation, and depoſition, reſpectively. I did not aſſert that the ſolution was effected by the menſtruum, but, on the contrary, denied it. Mr. Playfair's aſſertion, that cryſtallization is a paſſage from chemical ſolution to non-ſolution or inſolubility, is denied by Bergman; "*Sed non tantum vere ſoluta*

in

in aqua determinatas acquirunt formas, verum etiam ni fallor satis attenuata." Bergman, ii. p. 15. It is fufficient that the particles fufpended and fufficiently attenuated have an affinity to each other.

Page 22. "Barytic earth is well known to have a ftronger attraction to fixed air than common calcareous earth has, fo that the carbonate of barytes is able to endure a great degree of heat before its fixed air is expelled: accordingly, when expofed to an increafing heat at a certain temperature, it is brought into fufion, the fixed air ftill remaining united to it: if the heat be further increafed the air is driven off, and the earth lofes its fluidity." And, p. 185, "Carrara marble may require a heat of 6300° of Wedgwood to melt it in the open air; but under fuch a preffure as would retain this gas it cannot be inferred that it might not melt with the heat of a glafshoufe furnace. In like manner it may be true that 280 cubic inches of air acting on charcoal cannot effect the fufion of one grain of this marble after its fixed air is driven off from it; but we cannot from thence draw any inference applicable to a cafe where the carbonic acid is retained, and where the action of heat is independent of atmofpheric air." Now, in no experiment with which I am acquainted has native aërated barytes been fufed without the expulfion of its air, or union with the earth of the crucible. Dr. Hope, indeed, fufed it in a black lead crucible, but found it loft 23 per cent. nearly of its weight; which is the whole, or nearly fo, of the air contained, and accordingly it made but a very flight effervefcence with marine acid. Hence the pofition laid down, p. 22, that barolite or native carbonate of barytes may be fufed and ftill retain its fixed air, is founded on no experiment; but from all known experiments the contrary inference is fairly deducible with refpect to it, as well as with refpect to Carrara marble; nor is there any reafon to think that a lower heat, independent of the atmofphere, could have any other effect.

Page 201—203. The fact alluded to, namely, that fhells are found incorporated in the body of a rock at a great height near Guancavelica, I have fully ftated and explained in a differtation long fince printed, and which accompanies this letter; to which I fhall therefore beg leave to refer *.

Page 242. "Mr. Kirwan, in order to account for the magnitude of maffes of iron found in Siberia and Peru, fuppofes that fmall pieces of native iron have been originally agglutinated by petrol: this is, no doubt, the moft fingular of all the opinions advanced on the fubject; and, as it bor-

* See the next article in the prefent Number.—EDIT.

rows

rows nothing from analogy, it admits of no proof and requires no refutation." I was, however, led into this opinion by analogy with Mr. Gadd's experiments in the 32d volume of the Memoirs of Stockholm; for he tells us, that if clay and calces of iron be plentifully mixed with oil, they will form a mass which will harden even under water. If Mr. Playfair were acquainted with Mr. Chladni's opinion, that these masses were fragments of a broken planet that fell within the sphere of attraction of our globe, he might possibly think it the most *singular*; yet even so, it is probable he would not sacrifice the pleasure of bestowing that distinguished epithet on mine. However, as he judged my conjecture, I know not on what foundation, inconsistent with the principles of chemical science, I have mixed rust of iron with petrol, and afterwards with petrol to which sulphur was added, and found it disposed to coalesce in a few days.

P. 422. "One of Mr. Kirwan's objections to the deposition of materials at the bottom of the sea is thus stated:—'Frisi has remarked, in his mathematical discourses, that if any considerable mass of matter were accumulated in the interior of the ocean, the diurnal motion of the globe would be disturbed, and consequently it would be perceptible.' The appeal made here to Frisi is singularly unfortunate, as that philosopher demonstrated the contrary to Mr. Kirwan's position. The instance just given may serve as one of many to show what confidence is to be placed in that undigested mass of facts and quotations which Mr. Kirwan, without discrimination and without discussion, has brought together from all quarters." Mr. Playfair might, however, easily infer, from the loose manner in which Frisi is quoted, (namely, in *some* of his mathematical treatises, so different from my usual manner, in which the page I take from is mentioned,) that I had not that author before me; and, in fact, I took it from Mitterpacher's Physical Description of the Earth, p. 25, who says, that according to Frisi, in the case above mentioned, the velocity with which the centre of the globe would move would be increased; omitting the calculation, and the mention that the increased velocity would not be *sensible* for a long period of years. I hope therefore it is the only one out of the many quotations I have made in which any mistake can be found: if Mr. Playfair could find any other, he doubtless would have mentioned it. The attempt to weaken the force of the numerous facts I collected, adverse to the Huttonian theory, by calling them an *undigested* mass, is curious, and, if allowable, would furnish a very convenient and expeditious method of getting rid of

of them, but will not, I preſume, appear perfectly ſatisfactory to an impartial public.

Page 427. The fact relative to the deltas formed in the mouth of the Bourampouter Mr. Playfair thinks I have miſapprehended, becauſe major Rennell does not aſſert that rivers employ *all* the materials which they carry with them, and deliver none into the ſea. On the contrary, I think, they carry many of them into the ſea, but not to any great diſtance, much leſs into its unfathomable depths, as Dr. Hutton aſſerts. The fact relative to the extenſion of coaſts is now ſo well known to all modern geologiſts, that it were time loſt to dwell longer on it: that the deltas themſelves are diminiſhed by particles detached from them, and carried into the receſſes of the deep, is a remark which I do not recollect to have met with; but in ſome inſtances, where they conſiſt merely of ſand, they are often diminiſhed by the winds: that even the argillaceous particles are not carried far into the ſea, may be ſeen in Morſe's American Geography, p. 49, Iriſh edition.

I decline entering into any further diſcuſſion of Mr. Playfair's replies to ſome other objection made by me to the Huttonian theory. The intelligent reader will meet with many confident and arrogant aſſertions of which he probably will require ſome proof, as in p. 481 and 482; many that are perfectly unſatisfactory or even contradictory, as where he allows that the impulſive motion of the waves againſt the ſhores is greater at a *ſmall* diſtance from them, and yet aſſerts that the *detrites* of the ſhores are conveyed to a *great* diſtance. He alſo affirms with great confidence, that as the flowing of the tide requires juſt ſix hours, and the ebbing of it alſo ſix hours, the quantity of matter moved, and its velocity, muſt be juſt the ſame: p. 432. In the abſtract this is certainly true, and in the middle of the ocean; but in moſt harbours the contrary happens: thus La Lande tells us that in the harbours of Breſt, Dunkirk, Bordeaux, and Rouen, the ebb tide is about a quarter and often half of an hour ſlower than the flow: vol. iv. p. 117. Theſe exceptions, I am perſuaded, he is well acquainted with; but his *hurry and impatience* * (if I may be permitted to uſe his own expreſſions) to combat my aſſertions led him to overlook them. He is much at a loſs to account for the remains of elephants and of the rhinoceros found in Siberia, and thinks it moſt probable that they belonged to antient ſpecies of thoſe ani-

* Theſe are the cauſes to which he aſcribes the many miſtakes he ſuppoſes me to have committed in combating the Huttonian theory; to reaſon he thinks me incapable.

mals that could endure the severity of a Siberian winter? p. 475. If I had advanced such an opinion, it is probable he would be equally at a loss to find an epithet sufficiently severe to stigmatize it.

P. 481. It is evident, he says, that my geological writings are the work of a man who has not seen nature with his own eyes. This, I suppose, he infers from the total absence of observations made by myself. It is however pretty notorious here, that I have visited, traversed, and examined, most of the numerous mountains in this country; but I thought that in a controversy of this nature, the testimonies of persons who had taken no part in it, and who had seen much more than I have, would be more effectual and convincing: it is much easier to vilify my writings than to answer them.

No absurdity appears to Mr. Playfair so great as the attempt to connect the Mosaic history of the creation of the earth with any philosophical inquiry concerning it: this attempt he thinks injurious both to the freedom of philosophical investigation and to the dignity of religion: p. 477. The text of Moses he thinks covered with a veil which cannot be torn off, and must be considered as if it never existed: p. 478. Yet in other parts of his work he seems himself sensible of the extravagance of this assertion taken in the most extensive sense, p. 126; he seems to limit it to the *age*, *figure*, and *motion* of the *earth*; which no geologist ever pretended to infer from the Mosaic text, in which no mention of them is to be found, no more than they have the explanation of the act of creation itself; a notion which he also unjustly ascribes to them: but the series of events which took place after the creation of the earth, are too plainly mentioned to be overlooked or misunderstood: to say that this account is so obscure as not to be intelligible, is tantamount to saying that it is useless. It was never pretended that Moses intended to write a treatise of geology, any more than that Greek or Latin historians intended to give a treatise of astronomy from their occasional mention of eclipses or comets; nor is the genuine philosophical investigation of those phænomena any more impeded in one case than in the other: on the contrary, due notice is taken of their accounts by all astronomers. But there is a species of investigation, abusively called *philosophical*, which abstracts from historical accounts either of the creation or of the flood, as if the accounts given of both by Moses were unworthy of credit: to this objection the Huttonian theory is certainly liable, though I

never charged it upon it: fo far was I from wifhing to make ufe of what Mr. Playfair called poifoned weapons, as he unjuftly accufes me of having done.

It is in vain Mr. Playfair feeks to compare geology with aftronomy and zoology; neither of thefe fciences requires any notice to be taken of the original conftitution of their objects, their actual ftate being very nearly the fame as their primordial ftate; but, where hybrid fpecies occur, their origin never fails of being attended to.

In geology, the cafe is very different: here we meet with objects whofe original ftate muft have been very different from their actual ftate. Rocks or ftones prefenting regular forms muft of neceffity have been originally in a ftate from which fuch forms could arife. Maffes now hardened into ftone, but prefenting the impreffions either of vegetables or of other ftones, muft have been originally in a foft ftate. Calcareous ftones filled with fhells muft have been originally in a ftate fitted for the admiffion of thofe fhells; hence geologifts neceffarily recur to a ftate of inanimate nature prior to the prefent. This is admitted by Dr. Hutton as well as by Neptunifts; but he thinks the prefent ftate to have originated from a gradual deftruction of a former, as that did from a ftill more antient: ftill the moft antient of thefe worlds either refembled the prefent, or it did not: if not, we can fay nothing of it; if it did, the fame difficulties muft occur, and confequently its primordial ftate muft have been different from its fubfequent ftate, as this ftate is fuppofed to have been fimilar to the prefent. The cryftallized or foft ftate of our prefent rocks Dr. Hutton thinks proceeded from an igneous fufion of the materials of a prior world: but he cannot fuppofe this of the firft of thefe worlds; its fimilarity with ours muft therefore be otherwife accounted for.

I fhall here conclude my obfervations on Mr. Playfair's obfervations. Controverfies managed as this has been by him and Dr. Hutton, whofe favourite method of anfwering objections confifts in depretiating or fneering at the underftanding, and undermining the credit of their author, are a difgrace to philofophy, and fufficiently expofe the weaknefs of the caufe that obliges to have recourfe to fuch expedients.

I am, &c. &c.

Mr. Tilloch. RICHARD KIRWAN.

II. *An*

II. *An Illustration and Confirmation of some Facts mentioned in an Essay on the primitive State of the Globe.* By Richard Kirwan, *Esq. LL.D. F.R.S. and P.R.I.A.*

THERE is a remarkable fact stated in this essay, with respect to which the Mosaic account is fully at issue with the most plausible of the lately devised philosophic theories of the primitive state of the globe, namely, the emersion of some portion of land from the primæval ocean previous to the creation of fish: Moses expressly affirming, Buffon, the anonymous author of *L'Histoire du Monde primitif*, and many others, expressly denying it. In proof of the Mosaic account, I alleged that no petrifactions were found imbedded and incorporated in masses of stone in such countries as were elevated 8500 or 9000 feet above the actual level of the sea—for instance, in the great Tartarian platform and the elevated regions of Siberia—though in all inferior regions of the same extent such petrifactions were abundantly found, at least in limestones; but even in these none were found in those elevated tracts, as I proved by the testimonies of all the philosophic travellers who have traversed and examined them.

Bouguer and Don Ulloa* attest the same fact with respect to Quito and the lofty regions of South America, having met with none in ninety leagues from a little north of the equator to Cuenca, between 2° and 3° south of it, Quito being elevated 9374 feet above the level of the sea. I even doubted whether the petrifactions found by Mr. De Luc on mount Grenier, at the height of 7800 feet, were incorporated in the body of any stony mass; but he has since assured me that they were: now the shells he found being *cornua ammonis*, a species of those called *pelagicæ*, it would thence appear that the sea had risen still higher, though not above 1000 feet.

To repel this proof of the Mosaic account, it has been replied by the laborious, learned, and eloquent writer of *L'Histoire du Monde primitif*, and others, that the keen air existing in these elevated regions had long ago decomposed and consumed the shells that might have been there deposited; but, as the stones still remain, it is evident that the shells incorporated in their interior must also have remained, if any such were ever contained in them.

However, it is insisted that petrified shells have been found at a far superior height to that which I stated as the highest

* Bouguer, Figure de la Terre, p. 65. Don Ulloa, Mem. Philosoph. vol. i. p. 363.

limit at which they could be found, namely 9000 feet, for that thofe which I quoted as proofs of a fubfequent deluge, found, according to Don Ulloa, at the height of 14,220 feet in Peru, were in reality petrified. To this account, as it was only a hearfay report of Gentil, who had it from Don Ulloa, I own I did not give full credit; at leaft I thought the circumftance of their having been petrified and imbodied in a rock not probable: fince that time I have met with a work, compofed by Don Ulloa himfelf, entitled *Mémoires Philofophiques, Hiftoriques et Phyfiques*, in the firft volume of which, p. 34 and 364, the fact of the fhells being petrified and imbodied in a rock is fully ftated and confirmed: but I fhall here fatisfactorily prove that the height at which they were found did not exceed, nor even equal, 9000 feet above the level of the fea; and, fecondly, that they were left there by a deluge that fucceeded the emerfion of land from the primæval ocean.

Firft, Gentil tells us, *Mém. Par.* 1771, p. 439, in 8vo., that thefe fhells were found on a mountain near Guancavelica, a fmall town or village between 12° and 13° fouth latitude, which mountain, he fays, is far from being one of the higheft of the Cordelieres; and that on the fpot in which the fhells were found, the mercury in the barometer ftood at the height of 17 inches one line and $\frac{1}{4}$ = 17,103 inches; from which he infers that this fpot was elevated 2200$\frac{1}{3}$ toifes over the level of the fea, = 13,869 Englifh feet. This height I fhall now fhow to have been falfely eftimated.

Don Ulloa tells us, p. 34 of the abovementioned work, and Gentil repeats after him, that, at the village of Guancavelica, near but fomewhat below this fpot, the mercury ftood at the height of 18 inches one line and half. Now Bouguer, *Figure de la Terre*, p. 36, exprefsly fays that Quito is elevated from 14 to 1500 toifes only over the level of the fea, and is the higheft *inhabited* part of the globe: Guancavelica, therefore, which is inhabited, and muft have been well known to Bouguer, cannot be fo high as Quito. Quito was geometrically meafured, Guancavelica was not.

Bouguer alfo tells us, *ibid.* in note, that the mercury at Quito ftands at the height of twenty inches and one line: how then is it poffible that it fhould ftand at eighteen inches and one line at Guancavelica, which muft be much lower, if the barometer were not ill conftructed? No difference of temperature between Quito and Guancavelica could caufe fuch an enormous difference as two inches in the mercurial height. The art and neceffity of freeing barometers from air were not generally

generally known * before Mr. De Luc's immortal work on the modifications of the atmosphere, which was not published till upwards of thirty years after Don Ulloa's experiments. The air, then, remaining in his barometer, which he probably filled at Lima, in whose territory Guancavelica lies, under a pressure of 28 or between 27 and 28 (French) inches, must have considerably expanded and depressed the column of mercury under it when brought up a mountain of, perhaps, 7000 or 8000 feet high; and hence this mercurial column remained so low at Guancavelica as eighteen inches and one line.

That in these circumstances the air contained in the barometer might cause a difference of three inches or more between the height at which mercury purged of air would stand, appears by the experiments of Cassini, *Mem. Par.* 1740, *sur la Méridienne de Paris*, p. 172; for he found that the mercury, freed from air by ebullition in the tube, stood four or five lines higher than in barometers filled without that precaution. Nay, cardinal Luynes found the difference betwixt such barometers to amount sometimes to fourteen lines; *Mém. Par.* 1768, p. 490, in 8vo. How great must it therefore be in barometers transported to greater heights than that at which they were filled?

Moreover, Don Ulloa expressly tells us that the mountain on which these shells were found was *every where habitable*; *Mém. Philosophiques*, p. 34 and 35; which it could not be; and would be expressly contradicted by Bouguer, if its height were 13,000 English feet over the surface of the sea. From all which I conclude that the height of the mercurial column, if the barometers had been properly constructed, would have been about 22 French inches, = 23,44 English; and, as the temperature was remarkably cold, this would indicate a height of about 8200 feet above the level of the sea.

But, secondly, let the height be what it may, it is certain that these shells were deposited there after the emersion of land from the primitive ocean, and consequently by a subsequent deluge; for Don Ulloa expressly tells us, that in the same rocks in which these shells are found, *petrified wood* is also found; *Mém. Philosophiques*, p. 372. This wood must have grown on dry land, and must have been floated when

* I say, not generally known, because, though Mr. Du Fay had shown the advantage of expelling air from the mercury in the tube, in *Mém. Par.* 1723, and Cassini had followed that method in measuring the heights of Puy de Domé and Mont d'Or in 1740, yet it was not generally adopted until Mr. De Luc had proved its necessity, and perfected the method of performing it, in 1772. See De Luc, i. p. 58.

the

the ſhells were depoſited, ſince both are found in the ſame rocks. It muſt have been brought thither by a deluge, as no wood can at preſent grow there, as Don Ulloa alſo atteſts. The ſhells are for the moſt part bivalves, which geologiſts allow to form petrifactions of the moſt modern date.

Laſtly, La Peyrouſe mentions that he diſcovered marine ſhells on mount Perdu, the higheſt of the Pyrenees, at the height of nearly 10,000 feet. How he aſcertained the height is not mentioned: but that theſe ſhells were depoſited by the deluge is certain; for at the ſame height he found alſo the bones of land animals petrified. *Journal des Mines,* xxxvii. p. 59, 60, and 64.

III. *An Eſſay on the Colours obtained from the metallic Oxides, and fixed by Fuſion on different vitreous Bodies. By* ALEXANDER BROGNIART, *Director of the National Manufactory of Porcelain at Sevres, Engineer of Mines, &c.*

[Concluded from p. 348 of our laſt volume.]

A SMALL book, entitled *L'Origine de l'Art de la Peinture ſur Verre,* publiſhed at Paris in 1693; and the *Traité de l'Art de la Verrerie*,* by Neri and Kunckel, ſeem to be the firſt works that contain a pretty complete deſcription of the art of painting on glaſs. Thoſe ſince publiſhed, even the large work of Leviel, which forms part of the arts and manufactures of the academy, and what is ſaid in the *Encyclopédie Méthodique,* are merely compilations from the two preceding works.

It is very remarkable, that if the proceſſes deſcribed in theſe works were ſtrictly followed, as we did in regard to ſome, it would never be poſſible to form the colours for which they pretend to give recipes. They only put the able artiſt in the way, but he muſt always make amendments or additions. This was the caſe with C. Miraud, who has the care of preparing the colours at the manufactory of Sevres. He was obliged, rather from his own knowledge than the information contained in the above books, to make the colours employed for painting on glaſs.

The limits of a memoir will not allow me to enter into hiſtorical details reſpecting the art of painting on glaſs: a full hiſtory of it has been given in the work of Leviel above mentioned. The matters and fluxes which enter into the

* There is an Engliſh tranſlation of this work entitled *Neri's Art of Glaſs.*

 compoſition

composition of the colours employed on glafs are, in general, the fame as thofe applied to porcelain. Neither of them differ but in their proportions; but there are a great number of enamel or porcelain colours which cannot be applied to glafs, where they are deprived of the white ground which ferves to give them relief. When feen by refraction, feveral of them entirely change their tone, and affume a dirty tint, which can be of no ufe: we fhall make them known when we come to treat of colours in particular. Thofe which can be employed on this body change fometimes in baking, and acquire a great tranfparency. In general they are not beautiful; but, when placed between the light and the eye, they then feem to anfwer the only object that can be propofed in painting on glafs.

The baking plates of painted glafs prefents more difficulties than might be fuppofed. Care muft be taken not to disfigure the piece, or alter the colours: all the works we have read recommend a bed of gypfum. This method has fometimes fucceeded; but the glafs, for the moft part, becomes white and full of cracks. It appears that glafs too alkaline (and alkalies are the moft common in white glafs) fuffers itfelf to be attacked warm by the fulphuric acid of the fulphate of lime. We were eafily able to bake pieces of glafs much larger than thofe before painted, by placing them on very ftraight plates of earth or of foft porcelain.

Of Colours in particular.

After collecting the general phænomena exhibited by each clafs of vitrifiable colours, confidered in regard to the body on which they are applied, I muft make known the moft interefting particular phænomena exhibited by each principal kind of colours employed on foft porcelain and glafs in a porcelain furnace.

Of Reds, Purples, and Violets, made from Gold.

Carmine red is obtained by the purple precipitate of Caffius: it is mixed with about fix parts of its flux; and this mixture is employed directly, without being fufed. It is then of a dirty violet, but by baking it acquires a beautiful red carmine colour: it is, however, exceedingly delicate; a little too much heat and carbonaceous vapours eafily fpoil it. On this account it is more beautiful when baked with charcoal than with wood.

This colour and the purple, which is very little different, as well as all the fhades obtained from it, by mixing it with other colours, really change on all porcelain and in every hand.

hand. But it is the only one that changes on hard porcelain. Its place may be supplied by a rose colour from iron which does not change; so that by suppressing the carmine made with gold, and substituting for it the rose oxide of iron here alluded to, you may exhibit a palette composed of colours none of which change in a remarkable manner. This rose-coloured oxide of iron has been long known; but it was not employed on enamel, because on that substance it changes too much. As the painters on enamel, however, have become the painters on porcelain, they have preserved their antient method.

It might be believed that, by first reducing to a vitreous matter the colour called *carmine* already mixed with its flux, it might be made to assume its last tint. But the heat necessary to fuse this vitreous mass destroys the red colour, as I have experienced. Besides, it is remarked that, to obtain this colour very beautiful, it must be exposed to the fire as few times as possible.

The carmine for soft porcelain is made with fulminating gold slowly decomposed, and muriate of silver: no tin enters into it; which proves that the combination of the oxide of this metal with that of gold is not necessary to the existence of the purple colour.

Violet is made also with purple oxide of gold. A greater quantity of lead in the flux is what gives it this colour, which is almost the same crude or baked.

These three colours totally disappear when exposed to a great porcelain heat.

Carmine and purple have given us in glass tints only of a dirty violet. The violet, on the other hand, produces on glass a very beautiful effect, but it is liable to turn blue. I have not yet been able to discover the cause of this singular change, which I saw for the first time a few days ago.

Red, Rose, and Brown Colours extracted from Iron.

These colours are made from red oxide of iron prepared with nitric acid. These oxides are further calcined by keeping them exposed to the action of heat. If heated too much, they pass to brown.

Their flux is composed of borax, sand, and minium, in small quantity.

These oxides give rose and red colours capable of supplying the place of the same colours made with oxide of gold. When properly employed on hard porcelain, they do not change at all. I have caused roses to be painted with these colours, and found no difference between the baked flower and that

not baked, except what might be expected to result from the brilliancy given to colours by fusion.

These colours may be employed indiscriminately, either previously fused or not fused.

In a great heat they in part disappear, or produce a dull brick red ground, which is not agreeable.

The composition of them is the same both for soft porcelain and for glass. They do not change on the latter; but on soft porcelain they disappear almost entirely on the first exposure to heat, and to make any thing remain they must be employed very deep.

This singular effect must be ascribed to the presence of lead in the crust or glazing. I assured myself of this by a very simple experiment. I placed this colour on window glass, and, having exposed it to a strong baking, it did not change. I covered several parts of it with minium; and again exposing it to the fire, the colour was totally removed in the places where the red oxide of lead had been applied.

By performing this operation on a larger scale in close vessels, a large quantity of oxygen gas was disengaged.

It appears to me that this observation clearly proves the action of oxidated lead on glass as a destroyer of colour: it is seen that it does not act, as was believed, by burning the combustible bodies, which might tarnish the glass, but by dissolving, discolouring, or volatilizing with it the oxide of iron, which might alter its transparency.

Yellows.

Yellows are colours which require a great deal of care in the fabrication on account of the lead which they contain, and which, approaching sometimes to the metallic state, produces on them black spots.

The yellows for hard and soft porcelain are the same: they are composed of the oxide of lead, white oxide of antimony, and sand.

Oxide of tin is sometimes mixed with them; and when it is required to have them livelier, and nearer the colour *du souci*, red oxide of iron is added, the too great redness of which is dissipated in the previous fusion to which they are exposed by the action of the lead contained in this yellow. These colours when once made never change: they disappear, however, almost entirely when exposed to a porcelain heat.

These yellows cannot be applied to glass: they are too opake and dirty. That employed by the old painters on glass has, on the contrary, a beautiful transparency, is exceedingly brilliant, and of a colour which approaches near to that of gold. The processes which they gave clearly showed that

silver

filver formed part of their compofition; but, when exactly followed, nothing fatisfactory was obtained. C. Miraud, whom I have already had occafion to mention, has found means to make as beautiful paintings on glafs as the antients, by employing muriate of filver, oxide of zinc, white argil, and yellow oxide of iron. Thefe colours are applied on glafs merely pounded, and without a flux. The oxide of iron brings the yellow to that colour which it ought to have after baking, and contributes with the argil and oxide of zinc to decompofe the muriate of filver without deoxidating the filver. After the baking, there remains a duft which has not penetrated into the glafs, and which is eafily removed.

This yellow, when employed thicker, gives darker fhades, and produces a ruffet.

Blues.

It is well known that thefe are obtained from the oxide of cobalt. All chemifts are acquainted with the preparation of them. Thofe of Sevres, which are juftly efteemed for their beauty, are indebted for it only to the care employed in manufacturing them, and to the quality of the porcelain, which appears more proper for receiving them in proportion to the degree of heat it can bear.

I remarked refpecting the oxide of cobalt a fact which is perhaps not known to chemifts: it is volatile in a violent heat: it is to this property we muft afcribe the blueifh tint always affumed by white in the neighbourhood of the blue. I have placed exprefsly on purpofe, in the fame cafe, a white piece clofe to a blue one, and found that the fide of the white piece next the blue became evidently blueifh.

The blue of hard porcelain, deftined for what is called the ground for a great heat (*les fonds au grand feu*), is fufed with feld-fpar; that of foft porcelain has for its flux filex, potafh, and lead: it is not volatilized like the preceding, but the heat it experiences is very inferior to that of hard porcelain.

Thefe colours, when previoufly fufed, do not change at all in the application.

Blues on glafs exhibit the fame phænomena as thofe on oft porcelain.

Greens.

The greens employed in painting are made with green oxide of copper, or, fometimes, with a mixture of yellow or blue. They muft be previoufly fufed with their flux, otherwife they will become black; but after this firft fufion they no longer change.

They cannot ſtand a ſtrong heat, as it would make them diſappear entirely. Green grounds for a ſtrong heat are compoſed with the oxides of cobalt and nickel, but a browniſh green only is obtained.

Blueiſh greens called *celeſtial blues*, which were formerly colours very much in vogue, can be applied only upon ſoft porcelain; on hard porcelain they conſtantly become ſcaly, becauſe potaſh enters into their compoſition.

Theſe greens cannot be applied on glaſs: they give a dirty colour. To obtain a green on glaſs, it is neceſſary to put yellow on one ſide, and blue, more or leſs pale, on the other. This colour may be made alſo by a mixture of blue with yellow oxide of iron. I hope to obtain from oxide of chrome a direct green colour. The trials I have made give me reaſon to hope for ſucceſs. Pure chromate of lead, which I applied to porcelain in a ſtrong heat, gave me a pretty beautiful green of great intenſity and very fixed.

Biſtres and Ruſſets.

Theſe are obtained by mixtures in different proportions of manganeſe, brown oxide of copper, and oxide of iron from ombre earth. They are alſo previouſly fuſed with their flux, ſo that they do not change in any manner on ſoft porcelain, as lead has not the ſame action on oxide of manganeſe as on that of iron, as I aſſured myſelf by an experiment ſimilar to that already mentioned.

This colour fades very ſpeedily on glaſs.

Ruſſet grounds in a great heat, known under the name of *tortoiſe-ſhell grounds*, are made in the ſame manner. Their flux is feld-ſpar: no titanium enters into their compoſition, though ſaid ſo in all printed works. Titanium was not known at the manufactory of Sevres when I arrived there. I treated this ſingular metal in various ways, and never obtained but grounds of a pale dirty yellow, and very variable in its tone.

Blacks.

Blacks are the colours moſt difficult to be obtained very beautiful. No metallic oxide gives alone a beautiful black. Manganeſe is that which approaches neareſt to it. Iron gives an opake, dull, cloudy black, which changes very eaſily to red: the colour-makers, therefore, to obtain a black which they could not hope for from the beſt theoriſt, have united ſeveral metallic oxides which ſeparately do not give black, and have obtained a very beautiful colour, which, however, is liable to become ſcaly and dull.

Theſe

These oxides are thofe of manganefe, the brown oxides of copper, and a little of the oxide of cobalt. The gray is obtained by fuppreffing the copper, and increafing the dofe of the flux.

The manufactory of Sevres is the only one which has hitherto produced beautiful blacks in a ftrong heat. This is owing rather to the quality of its pafte than to any peculiar proceffes, fince it does not conceal them. It is by darkening the blue by the oxides of manganefe and iron that they are able in that manufactory to obtain very brilliant blacks.

Having here made known the principles of the fabrication of each principal colour, it may be readily conceived that by mixing thefe colours together all the fhades poffible may be obtained. It is evident alfo that care in the preparation, choice in the raw materials, and a juft proportion of dofes, muft produce in the refults differences very fenfible to an eye accuftomed to painting. A mere knowledge of the compofition of the colours does not give the talent of executing them well.

In recapitulating the facts above mentioned, to prefent them under another general point of view, it is feen:

1ft, That among colours generally employed on hard porcelain one only is fufceptible of changing, viz. carmine, and the tints into which it enters: that its place may be fupplied by the reds of iron, and that no colour then changes.

I have prefented to the Inftitute a head not baked, executed according to this method; and the painting of two rofes, that of the one baked, and that of the other not baked. It has been feen that there was no difference between them.

2d, That among the colours for foft porcelain and enamel, feveral change in a confiderable degree. Thefe are principally the reds of gold and iron, the yellows, the greens, the browns. They have not been replaced by others, becaufe this kind of painting has been almoft abandoned.

3d, That feveral of the colours on glafs change alfo by acquiring complete tranfparency. Thefe in particular are the yellows and greens.

4th, That it is neither by calcining the colours in a higher degree, nor previoufly fufing them, as fuppofed by fome, that they are prevented from changing, fince thefe means really alter the changing colours, and produce no effect on the reft. The change which feveral colours experience on foft porcelain and on glafs does not then depend on the nature of their compofition, but rather on that of the body on which they are applied.

Consequently, by suppressing from the colours of hard porcelain the carmine-of gold, which is not indispensably necessary, we shall have a series of colours which do not change, and which will be absolutely similar to those presented to the Institute in the year 6.

IV. *Memoir on Tubes rendered harmonious by Hydrogen Gas. Read before the Society of Physics and Natural History of Geneva, by* G. Delarive, *Ex-President of the Royal Society of Edinburgh, and Member of the Medical Colleges of London and Geneva**.

In a former sitting, our learned colleague professor Pictet communicated to the society a series of researches on tubes rendered harmonious by means of hydrogen gas, and explained the different musical phænomena to which these tubes give birth. He pointed out the influence of the length of the tube; of its breadth, and of the place where the gas is burnt; and explained the nature of the sounds produced. In regard to the cause of the sound, he offered only conjectures: as his labour was not directed to that object, it is under this point of view that I have resumed it.

Professor Brugnatelli, in my opinion, is the first person who published the experiment; which I shall endeavour to explain. It had been invented by a German: I shall here give a view of the principal circumstances attending it.

If a current of inflamed hydrogen gas be introduced into a tube the substance of which is elastic and sonorous, such as glass, metal, dry wood, &c., this tube, after the interval of some seconds, will emit a harmonic sound: if it be open at both extremities, the sound will be strong and full. The experiment may, however, succeed with a tube closed hermetically at one end, provided its diameter be so large as to admit of a circulation of the atmospheric air in sufficient quantity to maintain the combustion of the gas. The conditions essentially necessary for this purpose are: 1st, That the substance of the tube be elastic, proper for producing an echo; that is to say, for reflecting the undulations which proceed from the sonorous point: a tube of paper or pasteboard will emit no sound. 2d, The flame must be produced by a current of hydrogen gas. An inflamed jet of the vapour of spirit of wine or ether, a lighted taper, &c. are incapable of making the tube emit any sound.

* From the *Journal de Physique*, Fructidor, an. 10.

Let

Let us now examine what takes place in this experiment. There muft be a certain point, which may be called the *fonorous point*; it is at this point that the vibrations which communicate to the air an undulatory motion are produced. This point is the place of combuftion; for by changing the pofition of that place the founds may be varied, as M. Pictet proved by a feries of experiments. This gentleman obferved alfo in that point, by means of the fmoke with which he filled the tube, a continual fucceffion of vibrations. Thefe vibrations give birth to undulations, which are propagated with a known and determined velocity, and, ftriking the fides of the tube, are reflected with the fame velocity as that with which they reached them. When the diftance of the fides of the tube is fuch that the reflections backwards and forwards are ifochronous with the vibrations natural to the fonorous caufe, the found increafes in intenfity, and becomes mufically appreciable. It appears alfo that the reflected undulations re-act on the primitive vibrations produced in the place of combuftion, and render them harmonically regular with them; for a certain fpace of time is almoft always neceffary before the inftrument has acquired a regular and full found: the tone of the tube will be higher or lower according to the greater or lefs number of undulations which take place in a given time.

There is another effential fact to be obferved in the experiment which we here examine: the temperature of the column of air is not the fame throughout its whole length. At the fonorous point, that is to fay, the place of combuftion, the temperature is exceedingly high; it is fuch, that the extremity of the aperture of the glafs through which the hydrogen gas iffues is conftantly in a ftate of incandefcence: if an inflamed jet of the vapour of fpirit of wine or ether be fubftituted for a current of hydrogen gas, the heat is vifibly weaker. According to fome experiments it appears probable alfo that the temperature of the chamber where the experiment is made, and the purity of the air in the chamber, may have fome influence on the refult.

The object of my refearches was to difcover the caufe of thefe phænomena, and how, and by what means, thefe fonorous vibrations are produced. During the combuftion of hydrogen gas, it is well known that there is a production of water, and this water appears under the form of vapours. The place of the combuftion being at a high temperature, thefe vapours muft acquire a large volume; but, coming immediately into contact with air lefs heated, their volume muft be rapidly diminifhed. A vacuum therefore muft be formed,

into which the air rushes to be repelled by the new vapours, that contract in their turn. Is it from this alternate motion, produced by the great expansion and subsequent contraction of the vapours, that the sonorous vibrations result * ?

Such were the conjectures which might be formed on the probable cause of this phænomenon, when I accidentally met with a fact which appeared to me to give them some weight.

I had a thermometer tube about a line in diameter, at the extremity of which a small bulb was blown. In this bulb was a drop of water, which I wished to expel: for this purpose I exposed the bulb several times to the flame of a spirit-of-wine lamp. I was agreeably surprised to hear the tube emit a harmonious sound.

To repeat this experiment with success, the tube employed must be from 1 to 2 or 3 lines in diameter: its length may be about from 3 to 4 or 5 inches: it must have blown at one of its extremities a bulb the diameter of which is about triple that of the tube. It is not necessary that it should be regular. It even appears that, if it were a little flatted, the sound emitted would be higher. Into this bulb introduce a little quantity of water or mercury, and then expose it to a strong heat: that of a common spirit-of-wine lamp will, in general, be sufficient; but the flame must be large and strong when the operation is performed with a large tube. After the bulb has been exposed for some moments to the heat, it will emit a sound. Tubes of a large diameter produce a sound lower

* It appears to me probable that the sound produced by the air which rushes into the vacuum is more intense than that which results from an expansive force. The dreadful noise occasioned by the detonation of bubbles of hydrogen gas and oxygen is well known, and yet the lightest objects which surround the vessel are not even agitated by it; whence we may conclude that this phænomenon is produced by the sudden vacuum resulting from the destruction of the gas. The detonation of an inflammable gas pistol is much stronger than that of the air-gun, though the effect is less considerable; probably because in the pistol a vacuum succeeds the first expansive force. Every body is acquainted with that children's plaything called the humming top. It consists of a hollow sphere with an aperture at the circumference, which being made to turn rapidly on its axis produces a very strong humming noise. What is the cause of this noise? The same, in my opinion, as that above mentioned: the centrifugal force expels the air from the sphere through its aperture; a kind of vacuum is formed in it, the exterior air continually tends to enter it, and is immediately repelled, and hence a series of sonorous oscillations. — The Author.

The effect here spoken of seems rather to arise from the velocity with which the edge or lip of the orifice meets the air; for the same sound may be produced by directing a stream of air against the lip when the top is stationary. —Edit.

than others. The ſize of the bulb appears to me alſo to contribute towards the ſame effect. The ſound will be permanent for ſome moments; it will then gradually decreaſe, and at length will entirely ceaſe. By ſuffering the apparatus to cool, and taking care to make the liquid condenſed along the ſides of the tube to deſcend into the bulb, the experiment may be repeated as often as may be thought proper.

Such is the experiment by means of which, in my opinion, the phænomenon of the harmonious tubes may be explained in a ſatisfactory manner. Let us now examine what takes place in tubes with a bulb, and what are the eſſential conditions neceſſary to make them emit a ſound, and let us endeavour to diſcover the cauſe of this ſound. We ſhall then compare them with the tubes employed with hydrogen gas, and ſhall examine in what theſe two inſtruments reſemble each other in the effects they produce, the differences they exhibit under the ſame relations, and the cauſes of theſe differences.

The eſſential conditions neceſſary to make tubes with a bulb reſound are: 1ſt, That the veſſel has a bulb: I was never able to excite ſonorous vibrations in a tube ſimply cloſed at one of its extremities. 2d, This bulb muſt contain an evaporable liquid: water ſucceeds very well; but it is attended with the diſadvantage of forming in the tube, when it paſſes from the ſtate of vapour to the liquid ſtate, a ſmall drop which often obſtructs it entirely, and, ſometimes, falling on the heated part of the glaſs, occaſions a rupture. Mercury is not attended with the ſame defect: I was never able to produce ſounds with ether, ſpirit of wine, or concentrated ſulphuric acid. The quantity of liquid contained in the bulb is not a matter of indifference; it muſt be as ſmall as poſſible: if there be too much, the tube becomes filled with vapours, which completely expel the air from it, and, heating it every where in an uniform manner, it no longer emits any ſound. The third eſſential condition is the application of a ſtrong heat to the bulb while the reſt of the tube remains cold; for, if there be not a very ſtriking difference of temperature between the bulb and the tube, there will be no ſonorous effect. In the laſt place, the preſence of atmoſpheric air is indiſpenſably neceſſary: if it be entirely expelled, no effect can be produced. In all the periods of the experiment it will be found that the vapour fills only a certain portion of the inſtrument, and that it always contains air. I made ſeveral trials to determine exactly the ſpace occupied by the vapour at the moment when the ſound is heard; and I have found that, in ſmall tubes at leaſt, this ſpace is ſomewhat leſs than

than the volume of the bulb. To determine it, I ſhut with my finger the orifice of the tube: at the moment when it began to ſound, I immerſed the orifice in mercury, removed my finger, and left the apparatus to cool. The vapour became condenſed; and I could judge, by the quantity of mercury which the preſſure of the atmoſpheric air made to aſcend in the tube, the ſpace which the vapour had occupied.

Such are the four conditions eſſentially neceſſary for obtaining ſounds: a bulb at the extremity of the tube; the preſence of a very ſmall quantity of water or mercury in the bulb; the application of a ſtrong heat to the bulb while the reſt of the tube remains cold; and, in the laſt place, the ſimultaneous preſence in the apparatus of vapour and atmoſpheric air. It is not neceſſary to add, that the orifice of the tube muſt always be open. Let us now examine what may be the cauſe of the ſound. I wiſhed firſt to aſcertain whether any chemical decompoſition of the liquid employed took place. For this purpoſe I took a tube of ſuch a length that the liquid might be entirely condenſed in it. I weighed it carefully before I made the experiment: I then made it emit ſounds, and found, after producing this effect ſeveral times, that its weight had neither increaſed nor decreaſed; whence I concluded that caloric produces no chemical effect on the liquid, and that the latter merely undergoes ſucceſſive evaporation and condenſation. Is it to this evaporation, then, of the liquid, and its condenſation, that the ſounds ought to be aſcribed? At firſt I believed that this queſtion might be anſwered in the affirmative; but the following conſiderations made me change my opinion: I firſt obſerved that there might be a ſucceſſive evaporation and condenſation, without the tube emitting any ſound, on applying to the bulb a ſufficient heat, but leſs intenſe than that neceſſary for making the tube ſound. Secondly, in making the experiment with a drop of water, I conſtantly found that the moment when the apparatus began to enter into action was that when the whole of the water was evaporated, and, conſequently, when the heat acted on the vapour: if a ſingle atom of liquid remained in the bulb, the tube was mute. From this fact I conclude that the ſound is produced by the action of the caloric on the vapour, and the reaction of the latter on the atmoſpheric air. The following is the manner in which I conceive that this phænomenon takes place: The vapour contained in the bulb receives, by an addition of caloric conveyed to it from every part in a large quantity, an increaſe of volume and of elaſticity; it proceeds with force from the bulb to the tube, and expels the air contained in it; but this air and the ſides of

of the tube take from it, at the moment of contact, a portion of the caloric, its volume decreafes, at the fame inftant a vacuum takes place, and the air refumes its primitive fpace. A new addition of caloric reftores to the vapour its whole elafticity, a part of which it foon lofes in the fame manner. This is a confequence of the ofcillations of that nature which give to the air an undulatory movement. The undulations reflected by the fides of the tube become fonorous and appreciable when they are ifochronous with the ofcillations produced by the caufe I have indicated. From fome tubes it is impoffible to produce any found: in thefe I am of opinion that the reflected undulations cannot harmonize with the primitive ofcillations, and that the one deftroy the other. In tubes with bulbs, the found, after a certain time, becomes weaker, and at length ceafes. This may be explained by the propagation of heat along the fides. When the bulb is very warm, and the tube cold, the vapour which rifes from the bulb fuddenly lofes a part of its volume, and the ofcillations thus produced are ftrong and frequent; but when the tube has acquired a certain degree of heat, the vapour gradually decreafes in volume by paffing from a very hot temperature into a place lefs warm indeed, but which, however, has a fufficient degree of heat to make the ofcillations, which become weaker and fainter, to ceafe at length entirely. That fuch is the caufe of the ceffation of the found may be proved by applying a ftrong heat to the part of the tube already heated, maintaining at the fame time the fame degree of heat under the bulb: by thefe means the limits of the temperatures are again very abrupt, and the found will be reproduced in its full force. It may be readily conceived that the fubftance of the tube muft be fome matter a non-conductor of heat: glafs, therefore, is preferable.

Let us now compare the apparatus of a tube having a bulb with thofe tubes in which hydrogen gas is employed. In the latter we have every thing neceffary for the production of found, a vapour very hot, and confequently highly elaftic; for, as already obferved, the place of the combuftion is at fo high a temperature that the beak of the glafs is conftantly red. This hot and elaftic vapour, at the moment of its production, is in contact with the cold air, which enters the tube at the bottom and iffues at the top; its volume muft then decreafe a moment after it has touched that cold air: new hot vapours fucceed the former, and contract in their turn. This alternate expanfion and contraction gives birth to the undulatory movement of the air, and fonorous undulations.

We

We have already ſeen that an inflamed jet of ſpirit of wine or of ether cannot make the tube ſound. This is a new proof of what I have advanced, that to produce ſound there muſt be a great difference between the temperature of the vapour and that of the ſurrounding air. In this caſe there is a ſucceſſive formation and condenſation of vapour, for the water ſtreams along the ſides of the tube; but the place of combuſtion has a much inferior degree of heat to what it has when hydrogen gas is burnt, and conſequently the vapour produced has leſs heat as well as leſs elaſticity. This caſe is analogous to that already mentioned, when we ſaid that a ſucceſſive evaporation and condenſation of the liquid might be produced in a tube having a bulb, without any ſonorous effects, by expoſing the bulb to a certain degree of heat, but leſs intenſe than that neceſſary for making the tube emit a ſound. We ſhould not be ſurpriſed if leſs heat were produced by the combuſtion of ſpirit of wine, or ether, than by that of hydrogen gas, when it is conſidered that in the latter caſe all the caloric contained in this gas, and in the oxygen of the atmoſpheric air conſumed, becomes ſenſible heat, and unites itſelf entirely with the vapour produced. On the other hand, in the combuſtion of an inflammable ſubſtance, ſuch as ſpirit of wine, we have only the caloric of the oxygen conſumed, rendered ſenſible, and which is in a great meaſure abſorbed by the formation of carbonic acid gas, ſo that it is only the exceſs which joins the vapour. It is therefore not aſtoniſhing that we have not heat ſufficient to give to this vapour all the elaſticity neceſſary for the production of ſound: the preſence of the carbonic acid gas reſulting from the combuſtion may alſo be an obſtacle to the ſonorous vibrations.

In tubes employed with hydrogen gas, the ſound is much ſtronger than in thoſe having bulbs: beſides, in the former it is permanent, in the latter it continues only a few moments. The reaſon of this is as follows: In the apparatus with hydrogen gas the tube is open at both extremities, conſequently there is formed a current of freſh air, which enters at the bottom and iſſues at the top; this current of air ſweeping along with the hot and elaſtic vapours receives their impulſe, and, by taking from them a portion of caloric, diminiſhes their volume: we find here, therefore, the moſt eſſential condition for the production of an intenſe and permanent ſound, viz. a great difference between the temperature of the air and that of the vapour; and this difference always remains the ſame by the continual renovation of the air; but this does not take place in tubes with bulbs, and therefore the ſound they emit is weaker and of ſhorter duration.

From

From this principle, that the great difference between the temperature of the vapour and air is neceffary for the production of found, it may be eafily conceived that every thing which tends to augment the heat of the current of air, and to diminifh that produced by the combuftion of the gas, will tend alfo to weaken or even to annihilate the found of the tube: but thefe two circumftances are united in a warm chamber filled with people: the current of air, inftead of being cool, is hot, and the quantity of oxygen being there lefs, the heat produced will be of lefs ftrength. It needs therefore excite no aftonifhment, that in fuch chambers the experiment does not always fucceed.

Brugnatelli produced founds in tubes merely by the combuftion of phofphorus. Some philofophers, conceiving that the fonorous effects were owing in a peculiar manner to the hydrogen gas, have been induced to infer the prefence of that fubftance in phofphorus. From what has been faid, is it not more fimple to explain this phænomenon by the production of the phofphorous acid under the form of vapours, which receive a great degree of elafticity from the caloric difengaged during the combuftion, and the volume of which is foon diminifhed by the contact of the cold air? We find there the alternate expanfion and contraction neceffary for communicating to the air the undulatory motion proper for producing founds.

Such are the few obfervations I have had an opportunity of making on harmonious tubes; I hope they will prove in fome meafure interefting to thofe particularly engaged with this branch of philofophy, and that they will contribute towards making them pay attention to this curious fact hitherto neglected.

V. *On Painting.* *By Mr.* E. Dayes, *Painter.*

Essay V.

On Invention.

> Then, bold Invention, all thy powers diffufe,
> Of all thy fifters thou the nobleft mufe;
> Thee ev'ry art, thee ev'ry grace infpires,
> Thee Phœbus fills with all his brighteft fires.
>
> Mason's Fresnoy.

We fhould never forget that the value of every art arifes from the degree of mental capacity requifite to its production, and the degree of inftruction or pleafure refulting therefrom.

Hence

Hence invention is juftly ranked as the firft and moft noble part of the art; by it we diftinguifh the philofopher from the mere painter, for he whofe powers are confined to imitation deferves no better name.

Invention not only relates to the way in which the artift tells the ftory, but, in a higher fenfe, requires the aid of fuch probable incidents as may contribute to its further illuftration. Raphael, in his Paul at Lyftra, has finely contrived to fhow the miracle wrought, by making one of the fpectators, full of wonder and aftonifhment, lifting up the drapery to examine the limbs that have acquired their proper fhape. N. Pouffin, to convey an idea of the fize of Polyphemus, has placed him on the diftant mountains, and, by interpofing a great medium of air, has feparated him from the figures of the fame fize on the fore-ground, and thereby produced a gigantic effect that beggars all defcription. Barry, in his picture of Elyfium, has reprefented fpiritual beings conducting the earth, thereby indicating that the world is governed by a fupreme intelligence *.

The laws that govern hiftorical painting are not confined to it, but extend to every other fpecies of compofition: hence it becomes the moft noble part of the art, and from which all the others are but as fo many branches. It not only requires a thorough knowledge of the human figure, but its attire, with landfcape, architecture, &c.; fo that we may juftly term it the only univerfal part of the art.

Some men, who term themfelves artifts, move in an orbit fo confined that their motions are fcarcely difcernible without the aid of fome ftrong magnifier. Unfortunately for the arts, the trifler meets with the moft fuccefs; perhaps the higher parts of the art are not fo immediately within the reach of the capacity of the common obferver: like jewels, their intrinfic value is known but to few. Sir Jofhua juftly obferves, "that the loweft ftyle will be the moft popular, as it falls within the compafs of ignorance itfelf; and the vulgar will always be pleafed with what is natural, in the confined and mifunderftood fenfe of the word." Wifdom is rather an unprofitable commodity; for we too often find in life the

* The above is one of a feries of pictures preferved in the great room of the Society of Arts in the Adelphi. In thofe pictures the artift may be faid to have invented his fubjects altogether, and has fo connected them as to illuftrate that great moral truth, "that the attainment of happinefs, individual as well as public, depends on the cultivation of the human faculties." They exhibit a fine fyftem of ethics, at the fame time that they exprefs, in a moft determined and mafterly way, the beauty and advantages of legiflation.

moft

moſt ignorant the moſt ſuccefsful, and the moſt ſuccefsful the moſt honoured.

The great artiſts of former times did not only practiſe hiſtory, but portrait, nay even landſcape, and often excelled in architecture: then it was that one good work was enough to inſure a man ſuccefs and fortune, while now twenty haſty ones will ſcarcely furniſh him bread. Little and poor ſpirits have formerly made them ſeparate ſtudies, and their inability diſqualified them from teaching on a more liberal and extenſive ſcale, and now the practice of many is inſignificant and contemptible.

Man loves himſelf, and of courſe is intereſted in whatever relates thereto: hence the great end of painting ſhould be, recording actions of great perſonal patience, ſufferance, or heroiſm; but, above all, embodying ſome important moral truth for the edification of mankind.

Some lofty theme let judgment firſt ſupply,
Supremely fraught with grace and majeſty;
For fancy copious, free to ev'ry charm
That lines can circumſcribe, or colours warm:
Still happier if that artful theme diſpenſe
A poignant moral and inſtructive ſenſe.

MASON'S FRESNOY.

That part of painting termed the ornamental may pleaſe and delight; but he who in his works combines ſublimity with ſentiment, may be juſtly ſaid to have reached one of the higheſt points of human felicity, and does an honour to the ignorant by raiſing them from their own native inſignificance to rank with the higheſt order of earthly beings:

The dulleſt genius cannot fail
To find the moral of my tale:
That the diſtinguiſh'd part of men,
With compaſs, pencil, ſword, or pen,
Should in life's viſit leave their name,
In characters which may proclaim,
That they with ardour ſtrove to raiſe
At once their arts and country's praiſe. PRIOR.

In the choice of our ſubject we ſhould prefer thoſe beſt known, and, if poſſible, ſuch a one as may carry with it a general intereſt. As a poet, Milton was particularly happy in his Paradiſe Loſt; it is not the deſtruction of a city, or the conduct of a colony, but the fate of worlds, which involved the happineſs of mankind at large. The Greek and Roman hiſtory with their fables, alſo the hiſtory of our own nation, and the works of our beſt poets, furniſh infinite matter for ſtudy, as well as thoſe grand and ſublime ſubjects that occur in the Old and New Teſtament.

But in our choice from the above, or any other work, we are not bound, like cattle, to follow a leader; the subjects unhandled are endlefs; thofe in the Bible abound from the moft fimple paftoral to fuch as are in the higheft degree fublime. Befides, by exerting a proper degree of independence we fhall not only be left free to act, but thereby ftand the greater chance to give our works the character of originality. What could be more mortifying than to have it faid that the beft part of our picture was pitifully ftolen from another? This would render us like the poor animal when ftripped of his borrowed clothes, in which he looked fo formidable, when behold he proved a mere afs! Such a conduct cannot be juftified by any example found in a great mafter, whatever proofs he had given of his powers of invention, and it would be equally unpardonable in an artift of lefs celebrity. Nothing can be fo contemptible as that poornefs of fpirit that goes limping after another, crawling over objects like a flug, and leaving nothing but flime behind: he never can be great that does not greatly dare. The mind, acting from its own impulfe, will energize with more vigour than it poffibly could by feeing objects through the medium of another's feelings. He who imitates the manner of another debafes himfelf, by giving his company to the fervant when the miftrefs is ready to entertain him.

Prints and drawings are ufeful to pleafe the eye or enrich our thoughts, or, by having them before us, to keep up the fervour of the mind while employed on fimilar works of our own: then it is we may catch a grace from a figure, a grand or beautiful caft of drapery, or a thought that may give energy or brilliancy to our own, and that without copying. Collections of good prints are highly valuable to the artift; they add a noblenefs to his conceptions, aud raife and warm his imagination: fo do fine defcriptions in hiftory and poetry. The prints after Raphael, M. Angelo, and the Caracci, will afford a fund of entertainment and inftruction; and fine inftances of forms in the back-grounds of Titian and Paul Veronefe will be found with occafional good compofition. Rubens's prints by Bolfwert will be highly worthy attention, as well as thofe after the moft celebrated French and Britifh artifts.

We fhould be careful not to fuffer our purfuits to be interrupted by vulgar opinions or prejudices, but purfue our ftudies full of the conviction, "that patience and perfeverance will lead to perfection." Nothing can be more abfurd than to imagine one perfon too lively for fuch a ftudy, another too grave, or a third too fober or honeft for a genius: the fact is, if we fuffer the opinions of others to affect our choice or over-

power

power our refolves, we refign ourfelves up to the moft ignominious flavery, by giving up the right of regulating our own lives. When we have arrived at this part of the art, we muft place fome confidence in our own fkill, otherwife we fhall be liable to perpetual embarraffment from the various opinions of others; we fhould reft fatisfied if our works do not violate any principle in nature or rule of art. He who is doubtful of his own abilities will derive little advantage from the remarks of others, and the refult of his inquiry will produce a mafs of crude and independent hints, that cannot poffibly be reconciled, or collected into one point. A proper confidence is neceffary; he cannot hope to fucceed, who, before he begins, doubts if his abilities be equal to the undertaking.

As it is the great end of art to ftrike the imagination, when we have made choice of a fubject that is lofty, grand, or beautiful, we muft be careful that it does not fuffer in our hands by the introduction of poor or mean thoughts, ugly, infignificant, or common-place objects. Baffan, whatever fubject he chofe, reprefented it by the peafants of his own country; which deprived it of every merit but fuch as depended on colour and effect. How oppofite the conduct of Raphael in the Cartoons! who, knowing how much was expected from thofe who practifed the great ftyle, has infufed all the noblenefs he was mafter of into his apoftles, notwithftanding hiftory furnifhes no authority for fo doing. As we cannot make our hero talk greatly, we muft make him appear capable of great actions, by adding all the externals of dignity and grandeur correfpondent to high fentiment and great action; a power which all men wifh, but few attain.

As it is in our power, fo it is our duty, to produce that unity which nature does not always do. Thomfon has finely heightened the death of Amelia by the thunder-ftorm. A murder perpetrated in a gloomy day, or at night, will affect our feelings more ftrongly than in a broad flaring light.

Events become more compact, and of courfe more interefting, by making the inanimate fcenes of nature more dreadful or lovely, or by adding a more fublime caft to the human countenance.

Though many things in nature and art exceed expectation, yet nothing fenfible has the power to exceed or even equal the capacity of thought: it is from this power of the mind the artift derives his advantage. Mountains may be imagined loftier or more picturefque, lakes more extenfive and clear, rivers more rapid or flow, rocks more vaft and wild,

caverns more gloomy, ruins more majeftic, and the whole face of nature dreffed in fun or fhade as beft fuits our purpofe, while we may render the human figure more beautiful or grand.

The painter of hiftory, like the hiftorian, reprefents the *event, not the man*, which is the province of the portrait-painter and biographer.

The Dutch have treated hiftory under circumftances fo purely local, that Chrift has appeared in the ftorm in a common fifhing-boat with the tri-coloured flag flying; and Dalila cutting a lock from a huge black peruke of the end of the 17th century.

Two advantages refult from going to remote hiftory for our fubjects: one is, it becomes more venerable; another is, that the inaccuracies of *coftume* are not fo eafily perceived.

The two divifions of hiftory generally rank under the grand ftyle, and what sir Jofhua terms the ornamental, but which from its delighting in variety is better defcribed by the word *picturefque*, which is oftener applied, and not of fo debafing a nature. The picturefque is founded on an union of the regular and irregular, the grand or fimple, or the regular only: for inftance, the arch of a bridge which is uniform is fimple and grand, but being broken it becomes irregular or picturefque: decorations of ivy have a fimilar effect. A head and body feen in front, with the hair flowing uniformly on each fide, as we fometimes fee in the portraits of Georgione and Titian, is grand: incline the head, and vary the hair on one fide, it changes its character to the picturefque. Similar groups, nay, even fingle figures, perfectly alike, often characterize the higheft fimplicity of compofition, as in fome of Raphael's pictures, and of which there is a fine inftance by Titian in the church of the Friars of St. Francis at Venice; an etching of which, by Le Febre, is in every one's hand. Pouffin fhowed it in his landfcapes, in his buildings, and in the ftraight and parallel ftems and uniform foliage of his trees. The picturefque, on the contrary, is feen in the contrafted groups of Rubens; the croffing and winding of the ftems, irregular foliage of trees, and in broken buildings; *but ever accompanied with a beautiful choice*; for, as before obferved, if the picturefque was to be feparated from the beautiful: there would be nothing left worthy the dignity of painting.

The grand ftyle requires the greateft fimplicity of conduct: the rejection of all things little is neceffary to its completion, not only as to difpofition, form, the minutiæ of colour and effect, but to the total difregard of all the trickery of penciling: above

above all, if our ſubject is lofty, we muſt be careful not to admit any thought that is trifling or mean; a fault many of the old maſters are not entirely free from.

The drapery ſhould partake of the ſame great character: all the minute parts muſt be rejected, the folds ſhould be broad and ſimple, poſſeſs an eaſy communication, and gracefully follow each other as by chance.

The application of thoſe ſtyles muſt depend on the nature of the ſubject all together; the choice of the Roman ſchool required a ſimplicity of conduct which muſt neceſſarily run through the whole picture. The ſubjects of the Cartons would ſuffer by a deſtruction of the unity, from changing the character of any part: the unaffected compoſition, ſolemnity of colour, the broad and ſimple folds of the drapery, form a whole that would be deſtroyed by attaching ſhowy colour, or changing the character of the compoſition or drapery to the pictureſque. But ſportive ſcenes, feaſts, proceſſions, and marriage ceremonies, ſuch as were principally choſen by the Venetians, perfectly agree with that pictureſque effect ariſing from ſplendour of colour, oppoſition of light and ſhade, contraſt, and variety of draperies.

This character appears to ariſe (as before obſerved) out of the very nature of the ſubject. Who that wiſhed to repreſent an aſſaſſination would introduce ſplendid colours, or great vivacity of light? On the contrary, would he not rather uſe ſad and ſolemn ones, with darkneſs, obſcurity, and great depth?

What has reduced the Venetian ſchool is want of expreſſion. Paul Veroneſe, in his picture of Mary Magdalen anointing the feet of Jeſus, has made it a mere eating-match of Venetian ſenators; and Tintoret, in his Marriage at Cana, has made the company ſcarcely notice the miracle of turning the water into wine.

True hiſtory ſhould never have its gravity diſturbed by any improbable or impoſſible circumſtance. What can be more abſurd than Raphael's flying apoſtles in the Attila, the angels in the battle of Conſtantine, or St. Cecilia in the ſame picture with St. Paul, St. John, St. Auguſtin, and Mary Magdalen? The ſame artiſt in the School of Athens has confounded all the circumſtances of time and place. How unlike is the conduct of a great modern artiſt, who, in bringing together a number of great characters that lived at remote periods from each other, has wiſely placed them in Elyſium? In the picture by Titian, in the church of St. Francis in Venice (formerly alluded to), we find the Virgin

and Child, St. Peter, St. Francis, and Venetian ſenators, to the entire deſtruction of chronology.

Thoſe who chooſe to exert their fancy had better invent their ſubject altogether, and not falſify a fact by going to true hiſtory, where invention can never juſtify the introduction of allegoric fiction. It detracts from the merit of Conſtantine as a conqueror, by bringing the hoſt of heaven to his aid: without it we may ſuppoſe he could not have overcome his more powerful partner in the empire. But the higheſt joke is to find Heliodorus plundering the temple of Jeruſalem (as related in the ſecond book of Maccabees), and pope Julius preſent as a ſpectator.

> I loſe my patience, and I own it too,
> When works are cenſur'd not as bad, but new;
> While, if our elders break all reaſon's laws,
> Theſe fools demand not pardon, but applauſe. Pope.

Without racking our invention for fables above the comprehenſion of the vulgar, there are many fine moral ſtories for the practice of thoſe who can afford the time and expenſe neceſſary to their completion; ſuch as the patient reſignation of that firſt of mortal men, Socrates, at his death; Curtius leaping into the gulf; the Decii devoting themſelves for their country; the ſudden reverſe of fortune in Marius at the ruins of Carthage; the folly of Candaules in expoſing his wife's beauty to his friend Gyges; the deſire of fame in Cæſar weeping before the ſtatue of Alexander; the virtue of Phocion in refuſing the bribes of Alexander; and the piety of Æneas in preſerving his father from the flames of Troy; with numberleſs others that muſt occur to every one's recollection.

The Florentine and Roman ſchools have ſeized on the moſt prominent parts of the arts, and, having perfected them, left but little to do for thoſe who followed beyond embelliſhing: whatever was ſtrong and forcible they ſeized in their mighty graſp; hence thoſe who have ſucceeded them as they poliſhed have loſt vigour and expreſſion. The Caracci attempted it, and with ſome of their ſcholars were often ſucceſsful, and for dignity and expreſſion ranked next after the above great ſchools. The Venetians appear ſcarcely to have thought of it in the rich buſtle of their pictures. Rubens among the Flemings ranks firſt: and when the Dutch attempted at expreſſion it was always low and vulgar; Rembrandt was ſuch, with a deſperate bad choice of figure. Raphael for expreſſion juſtly ranks before any other painter, of which there are fine examples at hand in the Cartons at

Windſor

Windſor caſtle, and which by the firſt judges are ranked among the beſt of his works, if not the very beſt. They are unqueſtionably preferable to any of his pictures in the Vatican, for purity of invention and hiſtoric truth. His eaſel pictures are generally poor.

By expreſſion we do not confine ourſelves to the face merely, but to the juſtneſs of the general action. That expreſſion is juſtly placed at the head of the art is evident from its difficulty, for to expreſs well we muſt in ourſelves feel the paſſion we wiſh to repreſent. He who wiſhes to wring another's heart with anguiſh muſt feel as exquiſitely himſelf: hence the neceſſity of recurring to nature, and not depending on the feelings of another, as the manneriſt ever muſt. We ſhall obtain but little advantage in this inſtance from a model: we muſt therefore recur to ourſelves; and in ſo doing the looking-glaſs will become our beſt friend: for, as Pope obſerves,

They beſt ſhall paint them who can feel them moſt.

The paſſions, as they are called, by Le Brun are overcharged, ſo much ſo as to have become caricatures. There is no laying down rules for what muſt ever depend on the feelings. Next to nature, the antique heads of the Laocoon, the dying Alexander, the Niobes, and many others, will be well worth conſulting: but expreſſion muſt be general; we ſee agony in the fingers and toes of the Laocoon as ſtrong as in the face. Domenichino and Pouſſin were great in expreſſion; but, as before obſerved, Raphael is the firſt modern.

It would be an unpardonable neglect to overlook a work of Britiſh art, that for expreſſion would diſpute precedence with the beſt of the Roman ſchool. Where ſhall we ſee paternal deſpair repreſented with more force and truth than in ſir Joſhua Reynolds's count Ugolino, or the horrors of death pronounced in a more determined and maſterly manner than in the children? We need ſay no more: Sweetneſs and Truth were his handmaids; and when he died the Graces would no longer remain on the earth. Where encouragement has been offered, the Britiſh artiſts have done their duty: in portrait and landſcape they equal, if not exceed, the beſt; and in hiſtory ſome works have appeared honourable in the higheſt degree to the nation. They will be ſufficient to ſhow to poſterity the powers of the art in the time we live: a few good works are enough, perhaps, in an ungrateful age *.

If

* I am juſtified in uſing the words ungrateful age, by the ſhameful neglect ſhown at the ſale of Macklin's pictures by Britiſh artiſts. Art, like

If we wiſh to know much, we muſt ſee many things of a kind, that by comparing them we may acquire a more perfect idea of the thing than the real object conveys; and thoſe ideas we are bound to improve till we underſtand the true principles of general nature, or unaccompanied with thoſe peculiarities that mark the defects of the individuals in each ſpecies.

When we have determined on a ſubject, we muſt with all due expedition make a ſketch of the principal perſons concerned in the event, or whatever conſtitutes the feature of the picture, without regard to dreſs or any of the leſſer incidents, as much of the fire and ſpirit of the actions, as well as the grandeur of the whole, depends on the firſt impreſſion. We muſt then do by our ſketch as Virgil ſaid he did by his works, "lick them into ſhape;" for, as the firſt part depends on the imagination, ſo the ſecond is the reſult of judgment: we are then to prune or add till the whole comes into perfect ordonnance, chooſing ſuch objects as are ſtrikingly noble or beautiful, and adding ſuch acceſſory circumſtances as may beſt contribute to illuſtrate the ſtory. In our progreſs with the ſketch we may add a ſecond or third group, ſettle the dreſſes and the back-ground, whether landſcape or architecture, the diſpoſition of the maſſes, and complete the whole by ſlightly tinting it.

We are bound to preſerve a whole throughout our work, as well as an unity of time and place: we ſhould therefore avoid every thing local; even a well-known face or figure deſtroys intereſt, by rendering the work familiar.

Laireſſe whimſically deſcribes a picture of the deluge, painted by an artiſt of his time, as made up of abſurdities. Among other things jumbled together is "the grave of Mahomet, rolls of Virginia tobacco, a cardinal's cap, a child in a gocart, pickled herrings, a ſmutch-pot and pencils, all the toys from a Nuremberg toy-ſhop, the records of the imperial chamber at Spire," and, to crown the whole, "the Vatican," and the artiſt's own dear ſelf "ſitting on the fore-ground ſketching every thing after the life." The man muſt be ignorant indeed who could be guilty of

like beauty, having once withered, can never be reſtored. Conſtantine, with all his wealth and power, could not reſuſcitate it, but was obliged to rob antient Rome to adorn his new city. Rouſe, countrymen, rouſe! you will add to your own immortality, and give vigour to the labours of the artiſt, by encouraging the noble walk of hiſtory painting. How renowned have the popes Julius and Leo, with the Medici, become from ſo doing! The preſent opportunity loſt may never be regained. Why ſhould we not contend for the empire of wiſdom as well as of the ſea?

ſuch

fuch grofs errors. An artift poffeffing common fenfe will never act fo abfurdly as to mix in the fame picture things antique and modern; an error common among the Venetian, Flemifh, and Dutch mafters.

If the fubject we mean to handle lies in Egypt, Athens, or Rome, let us endeavour to tranfport ourfelves thither by the warmth and activity of our imagination, and, by removing every thing local, lead the fpectator through the delightful and magical mazes of fcience, fo that he may actually imagine the fcene tranfacting before his eyes.

VI. *Extract of a Memoir on Argental Mercury. Read before the French National Inftitute, by* C. CORDIER, *Engineer of Mines**.

THE mineral called formerly native amalgam of filver, and which fince the labours of C. Haüy is now known under the name of *argental mercury*, is one of thofe natural metallic combinations, the mineralogical and chemical properties of which had been the leaft perfectly defcribed and examined. It is however probable that an accurate knowledge of this fpecies would have been obtained, had not its great rarity prevented chemifts from facrificing the only fpecimens of it which they poffeffed in order to fubject them to complete examination. The places where argental mercury is found are the mines of Rofenar in Hungary, thofe of Morffeldt in the ci-devant Palatinate, now the department of Mont-Tonnerre, and particularly thofe of Mufchel-Landfberg in the fame country; thefe are the only mines by which it has been hitherto furnifhed.

Though this mineral is at prefent too rare to be the object of the labours of the miner, it will be feen that it deferves the attention of the mineralogift, and to make a figure among the moft remarkable of the metallic fpecies.

Argental mercury is found always diffeminated throughout the mafs of the veins, fometimes in very thin leaves which fill up the fiffures, fometimes in fmall cryftals totally engaged in the matrix, or entirely infulated in the cavities.

This mineral fubftance has the colour and refplendence of filver or polifhed tin, or rather more frequently of liquid mercury, becaufe it almoft always retains at its furface a thin ftratum of the laft mentioned metal.

Its regular forms are the dodecaedral-rhomboidal, and all its modifications.

* From the *Journal des Mines*, No. 67.

The

The ſmall lamellæform leaves of argental mercury are for the moſt part bent, and follow the undulations of the rock to which they are applied. Their ſurface is generally ſmooth and poliſhed, but much leſs than that of its cryſtals. This metal is eaſily ſcratched by a piece of ſharp-pointed ſteel. By ſcraping it loſes almoſt all its ſplendour, and becomes dull. When rubbed on copper it leaves a white metallic trace. It is brittle and eaſily broken: its conſiſtence approaches to that of martial pyrites. Its fracture is conchoid, and exhibits no appearance of laminæ. The fragments of it are indetermined, with very obtuſe edges.

Its ſpecific gravity, determined from a mean of ſeveral experiments, is 14·1192; argental mercury therefore, next to platina and gold, is the heavieſt of bodies. When this mineral is heated at the blow-pipe, the mercury becomes volatilized, and a ſmall button of ſilver may be eaſily obtained.

The varieties of the regular forms are, 1ſt, The perfect rhomboidal dodecaedron (fig. 1. Plate III). The incidence of the two contiguous faces is 120°. The cryſtals not being ſuſceptible of any mechanical diviſion, it is not poſſible to know preciſely whether this ſolid be the primitive form of argental mercury, as is probable, and as we ſhall ſuppoſe it to be, in order to have the expreſſion of the laws of decrement and the value of the angles. This ſuppoſition can produce no error, becauſe the reſults of the calculation may be eaſily transferred, ſo as to apply them to the octaedron, the tetraedron, or the cube, which are the only other forms poſſible.

2d, The dodecaedron truncated on the ſix ſolid angles compoſed of four planes. The ſix new faces are produced in virtue of a decrement by one row: they belong to the cube, and make with the faces of the primitive form angles of 135°. According to the ingenious method of C. Haüy, the abridged expreſſion of the laws of decrement which produce this form is $\overset{1}{P}\,\overset{1}{E}$.

3d, The ſame as the preceding, the place of each ridge of which is ſupplied by a facet making an angle of 150° with the adjacent primitive face: theſe new facets take place by the ſubtraction of a row of moleculæ on all the edges. Its expreſſion is $\overset{1}{P}\,\underset{1}{\overset{1}{B}}\,\overset{1}{E}$.

4th, The dodecaedron truncated on all the ridges and all the ſolid angles, and having new facets on the edges of the truncatures which take place on the edges, and the ſolid angles compoſed of four planes. This form, which had not been

been before obferved, is the moft complex of all thofe exhibited by mineral fubftances. It is produced by the interfection of the faces which belong to the following fix kinds of regular or fymmetric folids, viz. the cube, the octaedron, the rhomboidal dodecaedron, the folid with 24 trapezoidal facets, the folid with 24 ifofceles triangular facets, and the folid with 48 fcalene triangular facets. The complete cryftal is terminated by 122 faces. The expreffion of this form, reprefented fig. 2, is $P \overset{1}{\underset{1}{B}} \overset{2}{\underset{2}{B}} \overset{1}{A} \overset{1\,1}{E} \overset{3\,3}{E}$.

The incidence of the faces of the primitive form with thofe of the octaedron is 125° 15′ 52″; with thofe of the folid having 24 triangular facets is 153° 28′ 4″; with thofe of the folid having 48 faces 16° 53′ 36″.

Hitherto no complete anatomy of argental mercury has been publifhed; mineralogifts were fatisfied with acquiring an approximate knowledge of its compofition from fimple experiments: it was therefore of importance to determine with accuracy the elementary principles of this mineral, and to fix the proportions. This analyfis was attended with no kind of difficulty *.

Sixty parts of this mineral were expofed in a crucible to the action of a low heat, which was fucceffively increafed, and continued as long as was neceffary to volatilize all the mercury. The cryftals, without fuffering any fenfible lofs of volume, were changed into fpongy maffes, which towards the end of the operation funk down and united into a metallic button: the weight of this button was found to be 16·5 parts, from which it was concluded that the weight of the mercury volatilized was 43·5.

This button was perfectly malleable, and had all the appearances of the pureft filver. To afcertain its purity it was expofed to the action of nitric acid proved by nitrate of filver. The folution was effected without any refiduum.

Oxygenated muriatic acid was poured into the folution, and the precipitate of muriate of filver was collected on the filter. The liquor tried by carbonate of potafh furnifhed no precipitate: the filver then contained no foreign metallic fubftance.

In regard to the ftate of the mercury in its combination, it is certainly not neceffary to prove that it exifts in a folid ftate. To be convinced of it, nothing will be neceffary but

* The cryftals fubjected to analyfis were covered with a ftratum of liquid mercury, which was removed by preffing them between the fingers in foft wax.

to

to confider, firft, that it forms almoft three fourths of the whole mafs; in the next place, that the fpecific denfity of the natural combination not only furpaffes, by a great deal, the mean fpecific denfity of filver and liquid mercury, but alfo that it is much more confiderable than that of the latter metal, which is the heavier of the two. The fpecific gravity indeed of the combination, calculated according to the formula of C. Haüy, would be only 12·5448, fuppofing the mercury liquid, whereas it is 14·1192; that of the mercury is only 13·5681.

A hundred parts of argental mercury, folid and cryftallifed, contain then of folid mercury - -	72·5
Silver - - - - - - - -	27·5
	100

Two other trials, made indeed with quantities lefs confiderable, gave abfolutely the fame proportions.

The identity of the refults of the analyfis of this mineral, its peculiar fpecific gravity, its faculty of cryftallizing, its confiftence, and all the other mineralogical characters belonging to it, evidently prove that it ought to be confidered as a real chemical combination, poffeffing fixed and invariable proportions, and that it is with propriety that a particular fpecies has been formed of it in the mineralogical nomenclature.

It may be of utility to remark here how improper the denomination of native amalgam was to denote this mineral fubftance. The name ftill employed in chemiftry and the arts does not denote a folid combination, but a pafte-like mixture, compofed of exceedingly fmall cryftals of argental mercury, adhering to each other by the medium of a certain quantity of liquid mercury. The confiftence of the maffes of artificial amalgam is even very variable: it may be increafed or diminifhed at pleafure, fometimes by adding mercury, fometimes by taking away a part of this metal, interpofed by means of a proper filter, fuch as a piece of fhammoy leather. It is the difficulty, perhaps, of feparating entirely the excefs of mercury in the folid combination that has occafioned a belief that filver and mercury may be combined in all proportions: this opinion feems to be as unfounded as that in confequence of which argil, rendered ductile by the means of water, was confidered as a real combination, the proportions of which might be indefinitely varied. It is proper to add, that at the common temperature argental mercury is always perfectly folid, and befides that

that it is insoluble in liquid mercury: this has been ascertained by experiment.

An exact knowledge of the specific density of argental mercury, as well as of the proportions of its two component principles, has suggested the idea of making some researches in regard to the density of solid mercury. Chemists have set out with the supposition that the moleculæ of the two metals experience no dilatation nor penetration in combining: knowing the specific gravity of silver = 10·4743, that of argental mercury = 14·1192, and the ratio of the two metals $\frac{29}{11}$, it will be found that the specific gravity of solid mercury ought to be 16·2662. In the case of there being a penetration of moleculæ, as is probable, the real density would be somewhat less: on the other hand, if there be dilatation, it will be found to be more considerable. In a word, this approximative result ought the less to be neglected, as it is probable that it will be always very difficult to attain *directly* to an estimation perfectly exact.

VII. *Extract of a Notice, read in the French National Institute, on a new Variety of Epidote. By* CHAMPEAUX *and* CRESSAC, *Engineers of Mines* *.

THE substance which forms the object of this notice was found in the primitive chain which traverses the country of the Grisons, and unites the mountains of St. Gothard to those of the Tyrol.

It has always been found united to a variety of red garnet, which Saussure has described † as a particular species under the name of *hyacinth de Dissentis*. To complete the description of this species, he gives a short description of the substance which forms the subject of this article, and he gives it the name of *phrenite*, because he thought he could distinguish in it characters which brought it near to the phrenite of Oisans.

In this description we shall follow the method adopted by professor Haüy.

Essential Character.

Divisible in a direction parallel to the planes of a right rhomboidal prism, which form with each other angles of 114° 37′ and 65° 23′.

* From the *Journal des Mines*, No. 67.
† Voyage dans les Alpes, § 1902.

Physical

Physical Characters.

Specific gravity 3·3739. This character was proved on the pureſt fragments that could be procured.

Hardneſs. It eaſily ſcratches glaſs; it is with difficulty ſcratched by quartz; ſtrikes fire with ſteel.

Tranſparency. Pellucid on the edges.

Colour. Bright gray.

Electricity. None by heat; acquires none by long continued friction.

Geometric Characters.

Primitive form. A right priſm with rhombal baſes; inclination of the planes M and T of the priſm (fig. 3, Plate III.) 114° 37′ and 65° 23′. The diviſions parallel to the planes are generally very cloſe; the laminæ are ſeldom obſerved in the direction of the baſes.

Structure. Very ſenſibly lamellar: the natural joinings ſeem to be ſomewhat cloſer in one direction than in another.

Fracture. Conchoid, ſhining, with ſmall cavities: it takes place only in one direction, that of the baſes; in that of the planes of the priſm nothing is obtained but laminæ, which manifeſt the ſtructure.

Chemical Characters.

With the blow-pipe. On the firſt application of heat the colour becomes leſs dark; the angles and the ridges then fuſe into a yellowiſh enamel, which grows brown in a continued heat, and is converted into ſcoria: if a thin plate be ſubjected to experiment, it becomes corneous before it is ſcorified.

Acids, cold. Acids have no action on it.

It reſults from this examination, and particularly the conſideration of the eſſential character, that the ſubſtance in queſtion belongs to the epidote; for it can be divided in a direction parallel to the planes of a right rhomboidal priſm, which form with each other angles of 114° 37′ and 65° 23′. It ſometimes happens that there is obſerved above the planes of the priſm facets oblique to the axes, which might give reaſon to ſuppoſe that they are parallel to the baſes, and thence be led into an error reſpecting the determination of the primitive form; but an attentive examination ſhows that they belong to other cryſtals which penetrate the former; and beſides, the examination of a form, ſufficiently prominent to admit of applying to it the laws of ſtructure, has proved that obſervation agrees with calculation.

This

This form, which has not yet been deſcribed among the known varieties of the epidote, reſults:

1ſt, From a decrement by one row on the edges G of the priſm (fig. 3.) correſponding to the acute angles of the baſe.

2d, From a mixt decrement on the left, by four rows in breadth and three in height, on the other edges H.

3d, From a decrement by three rows to the left on the ſame edges. This is that which conſtitutes the new variety.

The preceding laws do not mark entirely the planes M and T.

4th, In the laſt place, from a decrement by one row on the acute angles E of the rhombus of the baſe. The latter reaching its limits, makes the face P diſappear entirely.

It follows from this ſtructure that the characteriſtic ſign of the cryſtal will be $\overset{1}{\underset{r}{G}}\ \overset{1}{\underset{M}{M}}\ {}^{3}\overset{4}{\underset{k}{H}}\ \overset{3}{\underset{x}{H}}\ \underset{T}{T}\ \overset{1}{\underset{n}{E}}$; and the form produced being a priſm of ten planes and diedral ſummits (fig. 4.), we may thence deduce the denomination of quadridecimal, which will expreſs the four faces of the ſummits and the ten of the priſm.

Calculation has given for the inclination of the face x produced on the adjacent plane M 163° 23′, and on the declining plane T 131° 17′; reſults which are agreeable to thoſe obtained by geometry.

Independently of the form already deſcribed there have been obſerved alſo ſecondary cryſtals preſenting at their ſurface parallel ſtriæ. This, no doubt, is that deſcribed by Sauſſure in the following words: *ſtriæ, as if in the form of baſtions.* In a word, we may mention as pſeudomorphic the forms of emarginated garnet, to which this epidote of Diſſentis has been aſſociated; for ſometimes it covers it entirely by being moulded over it, and ſometimes it is completely covered by it in ſuch a manner, that one of the two ſubſtances cannot be ſeen but by the fracture of the other.

The obſervation of this new variety proves that the determination of mineral ſubſtances merely by their exterior characters is exceedingly defective; for the latter by its faces is very diſtinct from the ſpecies to which it belongs, but the geometric characters aſſign to it in the methodical ſyſtem its real place.

We ſhall remark alſo that the epidote is a ſubſtance the varieties of which differ from each other according to the countries where they have been found: to be convinced of this, nothing will be neceſſary but to compare that of Dauphiny with that of Arendal and that of Diſſentis. Their aſpect

aſpect is ſo peculiar that nothing can prove their identity but analyſis and the laws of ſtructure.

We ſhall compare this new variety of the epidote only with the phrenite, becauſe it is under this name that it is deſcribed by Sauſſure: it differs from it by its ſpecific gravity in the ratio of 33 to 36, and by its ſtructure, as it exhibits evident ſections in two directions, while the phrenite exhibits only one: in a word, it is not electric by heat.

The rock which accompanies it is compoſed of the ſubſtance of the garnet, the epidote itſelf, calcareous ſtone, and quartz. Theſe elements ſometimes are in proportions nearly equal; but it happens for the moſt part that the matter of the garnet predominates. In ſome ſpecimens the epidote is diſpoſed in thin zones between cryſtals of garnet, on which it is moulded: it appears alſo in amorphous maſſes pretty voluminous. Nothing certain can be ſaid in regard to its poſition; but it may be affirmed that it is found in the cavities or fiſſures of primitive mountains. We do not think that it has ever yet been found in its proper place by any naturaliſt; and the caſe is the ſame with the other productions of St. Gothard. The dealers in cryſtals go in queſt of them, and ſell them to travellers.

VIII. *Note on a Variety of carbonated Lime found near Port Seguin, Department of Vienne. By* C. Cressac, *Engineer of Mines* *.

THIS variety, which has not yet been deſcribed, reſults from a combination of the three following laws of decrement:

1ſt, That which produces the priſmatic by a decrement of two rows in the inferior angle *e* (fig. 5. Pl. III.)

2d, That which produces the inverſe by a row on the right and left of the angle E.

3d, That which produces the equi-axis by a decrement of one row on the edge B.

The repreſentative ſign of this variety, repreſented fig. 6, is $\overset{2}{e}\,\overset{1}{\underset{c}{E}}\,\overset{1}{\underset{f}{E}}\,\underset{\substack{1\\g}}{B}$; it has been called by C. Haüy *co-ordonate carbonated lime*. This name is deduced from the poſition of the facets produced by the three decrements in queſtion.

* From the *Journal des Mines*, No. 67.

Theſe

Theſe facets are ſituated on the ſame ſide, and are ſeparated by parallel ridges.

Inclination of c to g	116°	33′	54″
——— of c to f	153	26	6
——— of g to f	143	7	48.

IX. *Experiments and Obſervations on certain Stony and Metalline Subſtances which at different Times are ſaid to have fallen on the Earth; alſo on various Kinds of Native Iron.* By EDWARD HOWARD, *Eſq.* F.R.S.

[Concluded from p. 336 of our laſt Volume.]

THE connection which naturally exiſts between one maſs of native iron and another, immediately turns our attention to the native iron in Siberia, deſcribed by Pallas; and this, we are told, the Tartars conſidered as a ſacred relic, which had dropped from heaven. The nickel found in the one maſs, and the traditionary hiſtory of the other, not to compare the globular bodies of ſtone from the Benares with the globular concavities and the earthy matter of the Siberian iron, tend to the formation of a chain between fallen ſtones and all kinds of native iron. How far any real affinity exiſts between theſe ſeveral ſubſtances, very obliging friends have afforded me an opportunity to form ſome judgment. I am indebted to Mr. Greville and Mr. Hatchett for portions of almoſt every known native iron; and the count de Bournon has done me the favour particularly to deſcribe them as follows.

Deſcription of various Kinds of Native Iron. By the Count de Bournon.

The great number of particles of iron, in a perfectly metallic ſtate, contained in the ſtone from Bohemia, and the ſaid particles being ſo near each other, naturally lead to ſome reflections reſpecting the exiſtence of native iron, which, by many mineralogiſts, is ſtill conſidered as problematical. Let us ſuppoſe for a moment, that theſe particles of iron were to approach ſtill more nearly to each other, ſo as abſolutely to come into contact, and in that manner to form a kind of chain, folded upon itſelf in the interior part of the ſubſtance, and leaving a great number of cavities between the links of the chain ſo folded. Let us then ſuppoſe, that the earthy ſubſtance with which theſe cavities are filled, being very porous, and having but a ſmall degree of conſiſtence, ſhould (as may happen by a variety of cauſes) be deſtroyed. It is plain,

plain, that if fuch a deftruction were to take place, the iron alone would remain; and, being thus left bare, it would appear in the form of a mafs, more or lefs confiderable, of a cellular texture, and as it were ramified; fuch a form, in fhort, as that in which moft of the native irons we are acquainted with have been found. May it not be fair to attribute to fuch an origin the native iron found in Bohemia, a fpecimen of which was prefented by the Academy of Freyberg to baron Born, and which came, with the reft of his collection, into the hands of Mr. Greville? May not fuch alfo, notwithftanding the enormity of its bulk, be the origin of the mafs of native iron found in Siberia, near Mount Kemirs, by the celebrated Pallas?

We have already feen, in the refults of the analyfes made by Mr. Howard, of the various ftones above defcribed, that he conftantly found a certain proportion of nickel mixed with the iron they contained. This circumftance recalls to our notice the obfervations that were made by Mr. Prouft, fome time ago, refpecting the mixture of nickel in the native iron of South America; and tends to give fome additional fupport to the opinion hinted at in the foregoing paragraph.

The circumftances juft mentioned naturally gave to Mr. Howard, as well as to me, a defire to know whether the native iron from Siberia, and that from Bohemia, were alfo mixed with nickel. Mr. Howard, confequently, loft no time in proceeding upon this important inveftigation. The native iron of Siberia prefents fome very interefting peculiarities, and has often been referred to, but has not yet been properly defcribed; it is therefore with great pleafure that I add the following defcription of it, and of fome other kinds of native iron, to the defcription I have already given of the various ftones faid to have fallen on the earth.

I feel the greater fatisfaction in doing this, as the noble collection of Mr. Greville contains two fpecimens of this iron, in perfect condition; one of which weighs feveral pounds, and was fent to Mr. Greville by Mr. Pallas himfelf: on this account, therefore, I enjoy an advantage that many of the authors who have fpoken of this iron probably wanted.

One of thefe pieces has a cellular and ramified texture, analogous to that of fome very porous and light volcanic fcoria; this is the ufual texture of the fpecimens of this kind of iron, which are preferved in the various mineralogical collections in Europe. When it is attentively examined, there may be perceived in it, not only empty cells, but alfo impreffions or cavities, of greater or lefs depth, and fometimes perfectly round, which appear evidently to be the refult of the com-

preffion of hard bodies which were fituated there, and which, when they came away, left the furface of thefe cavities quite fmooth, and having the luftre of polifhed metal. Here and there, in fome of thefe cavities, there remains a tranfparent fubftance, of a yellowifh green colour, of which I fhall treat more particularly when I come to the defcription of the fecond of the fpecimens above mentioned. It is very clear that the cavities here fpoken of owe their exiftence to this tranfparent fubftance; and that the polifh of the cavities arifes merely from the compreffion of the faid fubftance, and is the natural confequence of its furface having been in perfect contact with that of the iron.

This iron is very malleable: it may be eafily cut with a knife; and may be as eafily flattened or extended by means of a hammer. Its fpecific gravity is 6487; which, however, is very much under that of iron which has been merely melted, and has not been forged. The fpecific gravity of the native iron of Bohemia, which is nearly as malleable and as eafy to be cut, is ftill lefs: I found it not to exceed 6146. This low degree of gravity appears to be owing partly to the oxidizement of the furface of the iron, and partly to there being, in the interior part of its fubftance, a number of fmall cavities, which are often rendered vifible by fracture, and which have their furfaces alfo oxidized. The fracture of this iron prefents the fame fhining and filvery white colour as the common caft iron known by the name of white caft iron: but its grain is much fmoother and finer; it is alfo much more malleable when cold. Bergman fays that this iron is brittle when heated to a red heat. I have frequently tried it in that ftate, and have conftantly found it to be malleable. The fame remark may be applied to the native iron from South America, and alfo to that from Senegal.

The fecond of the two fpecimens mentioned above, and which weighs feveral pounds, prefents an afpect that differs, in fome refpects, from that of the preceding fpecimen. The moft confiderable part of it forms a folid compact mafs, in which there is not to be perceived the fmalleft appearance of pores or cavities; but there arifes upon its furface a kind of ramified or cellular part, fimilar, in every refpect, to the fpecimen already defcribed, and every where completely connected with the fubftance of the mafs itfelf.

If the compact part of this piece is examined with attention, it will be perceived that it is not entirely compofed of iron in the metallic ftate, but that it is mixed with nearly an equal quantity of the tranfparent fubftance of a yellowifh green colour, (fometimes alfo of a greenifh yellow,) already

 fpoken

ſpoken of in the deſcription of the other ſpecimen. This ſubſtance is mixed with the iron in ſuch a manner, that if the whole of the former could be removed, the remaining part would conſiſt merely of iron in the metallic ſtate, and would preſent the ſame cellular appearance as the preceding ſpecimen, and the ramified or cellular part of the ſpecimen now deſcribed.

This ſtony part, ſeparated from the iron, appears in the form of ſmall nodules, generally of an irregular ſhape, but ſometimes nearly globular: they have a perfectly ſmooth and ſhining ſurface, ſo as very often to preſent the appearance of ſmall balls of glaſs; a circumſtance that has led many perſons to ſuppoſe them the reſult of a real vitrification. Some of theſe nodules have ſeveral irregular facets, produced by the compreſſion of the iron in which they were incloſed; but I have never obſerved in them any appearances that could lead me to ſuſpect they had the ſlighteſt tendency whatever to aſſume a determined cryſtalline form.

This ſubſtance is always more or leſs tranſparent. It is ſufficiently hard to cut glaſs, but has no effect upon quartz. It is very brittle: its fracture is uſually conchoid; but I could perceive that it broke in any particular direction, in ſuch a way that I could conſider the fracture as a natural one. It becomes electric by friction. Its ſpecific gravity is from 3263 to 3300. It is very refractory: I kept it, for ſome time, expoſed to a degree of heat ſufficiently ſtrong to oxidize, to a conſiderable depth, the iron crucible in which it was placed, without its having undergone any alteration, except that of having acquired a greater degree of intenſity in its colour. Its tranſparency was not at all diminiſhed. I think, therefore, there is not the ſmalleſt reaſon to allow any probability to the opinion that it ought to be conſidered as a kind of glaſs.

Of all ſubſtances hitherto known, that with which it ſeems to have the greateſt analogy is the peridot, (the chryſolite of Werner,) to which ſome mineralogiſts have referred it. The reſult of Mr. Howard's analyſis of it is nearly the ſame as that of the analyſis of the peridot made by Mr. Klaproth.

The hardneſs and infuſibility of this ſubſtance are nearly the ſame as thoſe of the peridot; but it ſeems to have a rather leſs degree of ſpecific gravity: that of two very perfect cryſtals of peridot I found to be from 3340 to 3375. The cryſtalline forms of the ſubſtance here deſcribed, if ever we ſhould be able to determine them, would clear up our doubts reſpecting the analogy between the two ſubſtances. If we conſider the compact part of the ſpecimen now treated of, particularly the ſtrong connection that appears to exiſt between the iron and the

the tranſparent ſubſtance, and the great reſiſtance we experience when we attempt to ſeparate them, we cannot help being ſurpriſed, that almoſt all the ſpecimens of this maſs of metallic iron that have been brought to Europe are in the cellular ſtate already deſcribed, owing apparently to the total, or almoſt total, deſtruction of the tranſparent ſubſtance. But, beſides the fragility of this ſubſtance, the ſpecimen in queſtion helps very much to explain the above circumſtance, inaſmuch as many of the nodules of the tranſparent ſubſtance belonging to it are in a ſtate of real decompoſition. In that ſtate, they are changed into a white opaque ſubſtance, which, upon being lightly preſſed or ſqueezed between the fingers, crumbles into a gritty dry powder. This decompoſition may be obſerved to have taken place in various degrees: in many of the nodules, the ſubſtance is merely become friable, without being much altered in its appearance; whereas, ſome of thoſe which are in a ſtate of complete decompoſition are of an ochreous reddiſh yellow colour: it is, however, eaſy to diſtinguiſh that this colour does not belong to them, but is owing only to the oxidizement of the adjacent particles of iron.

From the above obſervations it will not be difficult to conceive the poſſibility of the total, or nearly total, deſtruction of the tranſparent ſubſtance; and alſo, the appearance the pieces of iron muſt naturally preſent when deprived of it. I cannot help obſerving likewiſe, that there appears to exiſt a very intereſting analogy between theſe tranſparent nodules and the globules I deſcribed as making part of the ſtones ſaid to have fallen on the earth. This analogy, though not a very ſtrong one, may lead us to ſuppoſe that the two ſubſtances are ſimilar in their nature, but that the globules are leſs pure, and contain a greater quantity of iron.

The native iron from Bohemia is a compact maſs, ſimilar to the compact part of the large ſpecimen of iron from Siberia, which has juſt been deſcribed: like that, alſo, it contains a number of globular bodies or nodules; but they are not in ſuch great proportion as in the Siberian iron. They are beſides perfectly opaque, and very much reſemble the moſt compact of the globules belonging to the ſtones ſaid to have fallen on the earth.

Examination of the Iron from South America.

I have already obſerved, that my experiments coincided with thoſe of Mr. Prouſt. He obtained 50 grains of ſulphate of nickel from 100 of this maſs. The proceſs I have ſo fre-

quently mentioned yielded me 80 grains of oxide of iron from 62 of the metal; which indicates about $7\frac{1}{2}$ of nickel, or about 10 per cent.

Examination of the Siberian Iron.

100 grains of this iron gave 127 of oxide of iron: hence it ſhould contain about 17 per cent. of nickel.

The yellow ſubſtance belonging to this iron was analyſed in the ſame way as the globular bodies, and the earthy parts, of the ſtone from Benares.

The proportions reſulting from the analyſis of 50 grains, and from ſome previous experiments on other particles, were,

Silica - - - - -	27
Magneſia - - - -	$13\frac{1}{2}$
Oxide of iron - - -	$8\frac{1}{2}$
Oxide of nickel - - -	$\frac{1}{2}$
	$49\frac{1}{2}$

Examination of the Bohemian Iron.

$26\frac{1}{2}$ grains of this metal left about $1\frac{1}{2}$ grain of earthy matter, inſoluble in nitric acid; and, by ammonia, afforded 30 grains of oxide of iron, inducing an eſtimation of nearly 5 of nickel.

Examination of Iron from Senegal, brought by General O'Hara, and given to me by Mr. Hatchett.

In this experiment, 199 grains of oxide were produced from 145 grains of metal: hence there may be an eſtimation of 8 grains in 145, or between 5 and 6 per cent. of nickel.

It will appear, from a collected view of the preceding pages and authorities, that a number of ſtones aſſerted to have fallen under ſimilar circumſtances have preciſely the ſame characters. The ſtones from Benares, the ſtone from Yorkſhire, that from Sienna, and a fragment of one from Bohemia, have a relation to each other not to be queſtioned.

1ſt, They have all pyrites of a peculiar character.

2dly, They have all a coating of black oxide of iron.

3dly, They all contain an alloy of iron and nickel. And,

4thly, The earths which ſerve to them as a ſort of connecting medium, correſpond in their nature, and nearly in their proportions.

Moreover, in the ſtones from Benares, pyrites and globular bodies are exceedingly diſtinct. In the others they are more or leſs definite; and that from Sienna had one of its globules

globules transparent. Meteors, or lightning, attended the descent of the stones at Benares and at Sienna. Such coincidence of circumstances, and the unquestionable authorities I have adduced, must, I imagine, remove all doubt as to the descent of these stony substances; for to disbelieve, on the mere ground of incomprehensibility, would be to dispute most of the works of nature.

Respecting the kinds of iron called native, they all contain nickel. The mass in South America is hollow, has concavities, and appears to have been in a soft or welding state, because it has received various impressions.

The Siberian iron has globular concavities, in part filled with a transparent substance, which, the proportional quantity of oxide of iron excepted, has nearly the composition of the globules in the stone from Benares.

The iron from Bohemia adheres to earthy matter studded with globular bodies.

The Senegal iron had been completely mutilated before it came under my examination.

From these facts I shall draw no conclusion, but submit the following queries:

1st, Have not all fallen stones, and what are called native irons, the same origin?

2dly, Are all, or any, the produce or the bodies of meteors?

And, lastly, Might not the stone from Yorkshire have formed a meteor in regions too elevated to be discovered?

Specimens of the Benares and Yorkshire stones have been deposited, by the president, in the British Museum.

X. *Considerations on* Dr. HUTTON'S *Theory of Rain: read before the Askesian Society, in the Session* 1801-2. *By* LUKE HOWARD, *Esq. F. L. S.*

IN an essay presented to the Royal Society of Edinburgh, and inserted in the first volume of their Transactions, Dr. Hutton investigates the rule directing the action and effects of heat and cold on the atmosphere, in order to establish a theory of rain on this principle, that the mixture of portions of air saturated with water, and at differing temperatures, will uniformly produce the condensation of a portion of water.

"This rule of condensation," says Dr. Hutton, "may be applied to the theory of rain, which is the distillation of water first dissolved in the atmosphere, and then condensed from that state of solution.

 "The

"The cause of rain, though often exerted, will not always produce the full effect; a scanty condensation of aqueous vapour produces *mists* on the earth, and *clouds* in the atmosphere above: and taking the gradation from one extreme of transparent atmosphere to the other of the densest cloud, from the falling of the gentlest mist to the heaviest rain, hail, and snow, we have an indefinite variety of appearances, all flowing from one simple principle."

On the visible steam produced by the breath of animals and by heated water, in a cold atmosphere, the author remarks that this appearance is not the effect of the genuine principles of heat and cold; that, to explain it, the knowledge of a particular law is requisite; and that the effects of heat and cold, in relation to air and vapour, are not uniform. The law alluded to is thus laid down:

"The dissolving power of air on water may vary in different proportions to the heat. The solution may vary as the heat, or in a greater or less ratio, i. e. the increments of each may be constant, or, those of the heat being constant, the increments of the solution may be accelerated or retarded.

"This may be represented geometrically (see fig. 7, Plate III). Let C H represent the scale of the thermometer; *a m b r*, perpendicular ordinates, the quantity of water held in solution by a given quantity of air of the temperatures *a* and *b*. Join *m r*, and draw the curves *m g r*, *m d r*: then it is evident that the ordinates to *m r* mark a solution varying as the heat; the ordinates to *m d r* a solution varying in a greater ratio, and to *m g r* in a less ratio than the heat.

"The ordinates to line *m r*, drawn from a point denoting the temperature of the mixture, represent the quantity of water contained (dissolved or not) in a unit of the mixture; for the ordinates *m a r b* are as the quantities contained in a unit of air of temperatures *a* and *b*; and as upon mixture the heat and water are uniformly dissolved (diffused?), they vary in the same proportion, and may be expressed by the same measure.

"Supposing equable solution, mix equal portions of saturated air, temperatures 10 and 40; the mixture of temperature 25 is represented by *o p*, which also represents the quantity of water in a unit of the mixture, and the quantity held in solution by a unit of air at temperature 25.

"So two portions of temperature 40, being mixed with one of temperature 10, the temperature produced 30 will be expressed by *u q*.

"In the curve *m d r* let equal portions of the solution at

40 and at 10 be mixed; then $o\,p$ is the quantity of water contained in this mixture at the mean heat 25, while $o\,e$ is the ordinate of folution: confequently $e\,p$ is the quantity of water that cannot be retained in folution in the mean temperature produced by the mixture.

"In the curve $m\,g\,r$ let equal portions at 10 and 40 be mixed; and the ordinate being drawn in the mean 25, $s\,k$ will be the whole power of folution, and the quantity of water that air is capable of diffolving in this degree of heat; but $o\,p$ being the quantity of water actually in the mixture, the air is underfaturated by the quantity $p\,k$.

"Thus the actual curve of evaporation being known, the effect of any mixture of two portions at different temperaments may be afcertained. If the folution of water in air increafes equally with the heat, there will be neither fuper- nor under-faturation in a mixture of portions at different temperatures.

"If the folution increafes with the heat but in a decreafing rate, there will be under-faturation; if it increafes with the heat but in an increafing rate, there will be fuper-faturation.

"The laft cafe applies to the phænomena of breath and fteam * rendered vifible in mixing with air colder than themfelves, and to various appearances that may occur in mixing together feveral portions of air differently faturated with humidity and at different temperatures: for it is not every mixture of air at different temperatures that forms a vifible condenfation, this effect depending on the degree of faturation with humidity. But if two portions of the atmofphere, both faturated with humidity, fhould be mixed, let there be but a difference in their temperatures, a condenfation proportionate to this difference will take place.

"At prefent, from the influence of the afcending fun,

* Aqueous gas at 212° (or fteam) produces vifible clouds in mixing with air at a lower temperature; but fteam is not a folution of water in air, neither is this appearance peculiar to it, but attends the cooling (in contact with air) of the tranfparent vapours of camphor and all volatile oils, as well as of benzoic acid and other fubftances quite infoluble in air. The fublimation of the latter very aptly exemplifies to a fpectator of it that momentary production of fnow which has been witneffed when the intenfely cold and denfe air of northern climates has been fuddenly admitted into the moift and warm atmofphere of the apartments in ufe there.

Vifible fteam arifes from the differing capacities of air and of vapour for caloric. The former, in acquiring temperature from the latter, robs it of a portion of its *conftituent* caloric: hence a momentary reproduction of water, which is afterwards depofited or diffolved according to circumftances. *Note by the Author of the prefent Effay.*

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two oppofite currents of air are formed in the fummer hemifphere, one moving along the furface of the earth from the pole to the equator, the other flowing above. Thefe oppofite currents, while feparate, might pafs each other without producing rain; but when fufficient portions are mixed, not only clouds but fhowers will be produced, fince the fudden formation of a mean degree of heat, in the mixture of two portions of different temperatures, muft condenfe a quantity of vapour fufficient to form rain.

"Without this law of condenfation of evaporation neither rain nor dew could take place any where in the fummer hemifphere, perhaps not even in tropical latitudes: there would be evaporation and a general tendency to faturate the atmofphere with water, but the mixture of different portions of air would only temper the faturation without producing a condenfation of vapour in the mean degrees of heat. At night, from the influence of the cold, the atmofphere would become gradually clouded; this cloudinefs would increafe to a general diftillation of condenfed vapour, which would be uniformly continued until the returning fummer fhould change the ftate of condenfation to evaporation; and inftead of the beautiful return of feafons, tempered with various degrees of heat and refrefhing fhowers, fix months rain and fix months drought would follow each other in an invariable fucceffion."

Such is the hypothefis which Dr. Hutton is willing we fhould confider as the theory of rain, and which he proceeds to apply to natural appearances; feeming to experience no great difficulty in folving by it every problem that occurs, as the folftitial, equinoctial, and other periodical rains, the comparative ftate of different climates and of land and fea, as to its frequency and quantity, &c. But, if we except a fhort remark on hail and thunder ftorms (which feems only to give occafion to a confeffion of our imperfect knowledge of atmofpherical electricity), in no inftance does the doctor avail himfelf of the aid of any other principle than the mixture of currents of air in traverfing the irregular furface of the globe, and confequent precipitation of water, to account for the whole train of phænomena conftituting the fubject of meteorology.

The fimplicity of this theory, the impofing air of a diagram at its introduction, the ingenious and defcriptive manner of the application, all contribute to render it fufficiently plaufible. It is rather extraordinary that the objections urged againft it by De Luc * fhould have extended no further than

* Idées fur la Météorologie, tome ii. p. 67.

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it appears they did. It would however be readily granted, I ſuppoſe, by each of theſe philoſophers, that hypotheſes, of whatſoever kind, ought not to be admitted into ſcience without the moſt rigorous examination, and that doubt has a right to keep the door ſhut until ſome paſſport of the demonſtrative kind is obtained either from nature or experiment. A geometrical repreſentation of what *may be* is not a ſufficient foundation whereon to aſſert what *is* a law of nature. Let us therefore examine how far this theory, which does not appear to be ſupported by any direct experiment, will bear the teſt of the excellent and deciſive ones whereon the doctrine of capacities has been eſtabliſhed by Black, Crawford, and Lavoiſier.

The author firſt aſſumes, as a law of nature, the poſition, that the ſolution of water in air increaſes with the temperature (heat), but in an increaſing ratio. On this he grounds a ſecond, the ſubſtance of which is, that if two portions of air, ſaturated with water and at differing temperatures, be mixed, the mean proportion will not be ſoluble at the mean temperature, and therefore a part will be precipitated.

The firſt poſition may be true, or it may not; perhaps nothing ſhort of actual experiment can ſatisfactorily aſcertain the actual curve of evaporation *.

The ſecond depends entirely on conditions which the doctor has taken for granted in each of the three caſes of evaporation ſtated by him, and which, on the received principles of caloric, can belong to no one of them. Theſe conditions withdrawn, the theory of rain, like its ſubject, falls to the ground, and the diagram proves as unſubſtantial as the bow with which the ſhower is decorated. To make this appear, it is only neceſſary to produce the following practical reſults, which apply equally, whether we regard caloric as matter or motion.

A homogeneous ſubſtance, or two ſubſtances having equal capacities for caloric, being mixed in equal portions at unequal temperatures, the temperature of the mixture is found to be in the arithmetical mean.

But heterogeneous ſubſtances, and thoſe in other reſpects homogeneous, but differing in capacity, being mixed in like manner, give a temperature which either exceeds or falls below the arithmetical mean, and approaches towards that of the two ſubſtances which poſſeſſed the greater capacity.

* Experiments deciſive of this very queſtion were made about this time, and the reſults preſented to the Literary and Philoſophical Society of Mancheſter by John Dalton, eſq. We ſhall have occaſion to notice his paper further on.

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The capacity of water (which Crawford terms the comparative heat) being taken at 1,000, that of air proves by his experiments to be as 1,790, and that of aqueous vapour as 1,550, at equal weights and temperatures.

Then if to dry air we add ſucceſſive portions of water at increaſing temperatures, we are forming a *compound* (not merely heating a *homogeneous* maſs), the nature of which, as in all other reſpects, ſo in that of the capacity for caloric, muſt ſtill continue approaching to that of aqueous vapour.

Now in any two portions of this compound, *formed* at different temperatures, the capacities will differ. It will be leſs in that which was ſaturated at the higher temperature; and whatſoever may have been the preciſe rate at which the ſolution advanced at increaſing temperatures, the mixture of the two portions will not produce a temperature in the arithmetical mean, but below it, as being moſt influenced by the drier portion.

Thus is the principal condition invalidated, viz. that portions of ſaturated air at differing temperatures will poſſeſs, after mixture, a temperature in the arithmetical mean. This argument may appear at firſt ſight ſtill to favour the concluſion reſpecting the mixture in the curve *m d r*, ſince, if precipitation take place at the mean temperature, much more ſhould it at a lower than the mean: but perhaps it may be eaſy to demonſtrate, on the ſame principles as before, that the temperature of ſuch a compound, as it reſults from this circumſtance of mixture only, will in no caſe affect the ſtate of ſolution, and that neither ſuper- nor under-ſaturation will enſue therefrom.

We will take for this purpoſe the curve *m d r*, and examine the real circumſtances of a ſolution advancing with the temperature but in an accelerated ratio; premiſing that the queſtion regards the effects of heat (caloric) *only* as the cauſe both of increaſed temperature and increaſed ſolution, and that, according to Crawford, equal additions of this (the capacity of the receiving body continuing unchanged) produce equal expanſions in the common thermometer.

That the ſolution of water in air goes on increaſing with the temperature of the compound is true, and it is equally ſo that it increaſes *at the expenſe of that power which gives the temperature*; for water held by air is itſelf in the ſtate of gas, and gas of whatſoever kind requires a large proportion of caloric for its conſtitution, which is not at all meaſurable by the thermometer.

Suppoſing therefore a unit of *dry* air at a certain temperature to conſiſt of 0,005 meaſures of liquid baſe and 0,995 caloric,

caloric, and that one part of caloric will raiſe its temperature one degree in any part of the ſcale; if we wiſh to convert this into a unit of *moiſt* air at the ſame temperature, it will not be ſufficient merely to add the proportion of water, ſuppoſe 0,001; for this water, being itſelf a *liquid baſe*, will require nearly as much *additional* caloric to conſtitute it gas, as the portion of air which was neceſſarily excluded from the unit took away with it. When we have added this proportion of caloric (which would have raiſed the dry air many degrees in temperature) together with the water, we ſhall have a unit of ſaturated air.

Further, if we would raiſe the temperature of the latter 10, 20, or 200 degrees, and ſtill preſerve the ſaturation, we ſhall find it impoſſible to proceed without an expenſe of power adequate to the rate of ſolution, beſides that proportion which is employed in raiſing the temperature through thoſe ſucceſſive intervals of the ſcale which are taken as the ſtandard of ſolution.

Now, in the caſe of equably advancing ſolution, if, as often as the thermometer has riſen 10°, a quantity of caloric equal to 100° has been imperceptibly ſupplied in addition, this is of no importance in the iſſue, ſince the temperature is ſtill a true *proportionate* meaſure of the power of ſolution in the extremes and in the mean: but in thoſe of accelerated and retarded ſolution it is otherwiſe; for here the very terms of the propoſition require that, as we advance in the ſcale, each degree of temperature may anſwer to 10, 12, 16, 24, of ſolution, or inverſely, and conſequently to ſimilar proportions of *added power*. Now if in each unit ſucceſſively ſaturated at different degrees there enters the due proportion of power which it needs muſt, then in every mixture that can be made of them the total power of ſolution as well as the whole quantity of water will be preſent, and there will be neither ſuper- nor under-ſaturation let the temperature reſulting from the mixture be what it may *.

Admitting, therefore, that caloric, or the *cauſe of temperature*, is alſo a neceſſary conſtituent part of aqueous vapour in whatſoever way it be formed, and that the doctrine of capacities is well founded, we muſt reject the theory of Dr. Hutton altogether.

P. S. Whether the phraſe of "the diſſolving power of air on water" was connected in the mind of Dr. Hutton with

* The remainder of the paper, as read before the ſociety, is ſuppreſſed by deſire of the author, who has communicated what follows in its place, and in which his reaſons for this will appear.—Editor.

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the idea of some other power operating jointly with the heat, such as an attraction between the base of air and water, I am not qualified to determine; but were it so, this would in no-wise affect the previous reasoning, as the conclusion rests entirely on the temperature, *i. e.* in the doctor's view, the caloric present, though they are in fact two distinct considerations which he has blended.

In the concluding part of this essay, as it was originally written, I had discussed the subject of the solution of water in air, and the several modes of its precipitation, on chemical principles; regarding moist air as a ternary compound of base of air, water, and caloric, formed and subsisting by chemical attractions, and decomposed by the operation of the same.

Having since perused the excellent work of my friend John Dalton *, which I have before alluded to, and having seen and repeated some of the principal experiments therein detailed, I must acknowledge that, although I might plead the authority of a Kirwan † in support of the chemical theory of evaporation, I am now disposed to give up the idea of a proper *solution* of water in air *in toto*.

It appears to me that nothing need be more clear, simple, and conclusive, than the experiments and deductions by which the author attempts to prove that the evaporation of water and several other liquids is a process uniformly regulated by their temperature, the effect of the latter in equal surfaces being the same *in vacuo* and under the full pressure of the atmosphere; the presence of which has no other influence than by its motion to multiply the surface of the liquid and carry away the vapour produced; whence the difference of quantity evaporated in equal times in a moving and a stagnant atmosphere. The solvent power of air on water may also, therefore, be safely classed among those causes which are not needful to the effect in question, and therefore not to be retained in philosophical reasoning.

* Experimental Essays on the Constitution of mixed Gases; on the Force of Steam or Vapour from Water and other Liquids in different Temperatures, both in a Torricellian Vacuum and in Air; on Evaporation; and on the Expansion of Gases by Heat.—*Manchester Memoirs*, vol. v. part 2. 1801.

† Of the Variations of the Atmosphere, inserted in the Irish Transactions 1801.

XI. *General*

XI. *General Confiderations on Vegetable Extracts.* By C. Parmentier.

[Concluded from p. 386 of our laft Volume.]

Juices of Plants.

To prepare thefe juices, they recommend to collect the plants when they are in full vegetation, to clean them carefully, to pound them in a marble mortar, to prefs them inclofed in a hair bag, after having added to them a little water, but only when they are either a little too aqueous or too mucilaginous.

All the fap-veffels of the plant, or others, are broken by the action of the peftle; all the liquids which they contained flow off, together with the green fecula and the attenuated remains of the vegetable.

They recommend to purify the juices either by reft; or by the heat of boiling water, or by means of the white of an egg, or by making them pafs through gray paper.

The firft method is fit for the juices of fruits.

The fecond may be employed for all the juices of herbs deftined to make extracts.

The third may be employed for all juices, infufions, or decoctions, that do not contain tannin.

The fourth is neceffary for all juices the virtues of which exift chiefly in the volatile principles.

It is preferred in pharmacy for magifterial juices, whether they be volatile or not; the two vifcous juices excepted.

Maceration—Infufion—Decoction.

In maceration, the cold water is attracted by the dry vegetable fubftances: it introduces itfelf into them, fwells them up, and renders fluid whatever is foluble.

It has been found that maceration is fufficient to obtain from quaffia, and even quinquina, the real active parts contained in them.

In infufion, caloric more abundant than in maceration renders the water more penetrating, more active, and more folvent; it becomes charged with a much greater number of the principles of the vegetable. The preparers of medicines make ufe of it in preference for dry herbs and for leaves, which, like fenna, for example, cannot bear ebullition without lofing their virtues.

In decoction, the water faturated with caloric acquires a much greater energy: it penetrates in a more intimate manner

ner the vegetable fubjected to its action; it forces to become foluble the fubftances which were not fo at a lower temperature; it melts and feparates thofe which are oily or refinous; it diffipates thofe which are volatile; and feveral of them it combines or decompofes.

They expofe to the action of boiling water thofe plants or parts of plants only which are exceedingly hard, and in which there exifts nothing volatile; and they often fubject thefe fubftances to maceration and infufion before they expofe them to ebullition.

In evaporation, the water charged with the foluble principles of the vegetables gradually abandons them to unite with caloric, and to form with it a volatile fluid known under the name of vapour: by thefe means, the principles before diluted become concentrated, and affume confiftence, the ftate and name of extracts.

They prefcribe a gentle fire for the evaporation of the juices, macerations, and infufions, and a ftronger fire for decoctions, taking care to choofe large and fhallow evaporating veffels, and to ftir the liquors to facilitate the evaporation of the water, and to prevent the extract from being burnt.

And to prevent that alteration of which the principles of vegetables, when highly diluted with water and expofed to the heat of an evaporation too long continued, are fufceptible, they recommend to employ only the neceffary quantity of water, paying attention to the folidity of the fubftances expofed to maceration, infufion, and decoction. They take care alfo to employ for all their operations very pure water, fenfible that it is only when it is in this ftate that it is fit for boiling pulfe.

During the evaporation of feveral juices or decoctions, fome phænomena occurred which did not efcape their notice.

They remarked, when preparing feveral extracts which they called faponaceous, that liquors became turbid; that their furface was covered with a pellicle which feparated into flakes, were precipitated, and formed incruftations fufceptible of being burnt at the bottom of the evaporating veffels.

It was Baumé in particular who paid attention to thefe precipitates; he fays they were faline.

The preparers of fuch medicines have alfo found that, during the cooling of the decoctions of roots or barks abundant in refinous matter, and during the evaporation of feveral of thefe decoctions, precipitates more or lefs abundant were formed, which, according to the opinion of Baumé, were owing to the refin, more or lefs altered, of the vegetables employed.

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Theſe precipitates, ſome of which were thought by Baumé to be ſaline and others reſinous, have been conſidered by Pelletier as earthy ſubſtances, and are aſcribed by the modern chemiſts to the union which ſeveral of the immediate principles of vegetables contained in the juices have formed with oxygen, which makes them loſe their ſolubility in water.

C. Deſchamps junior, apothecary at Lyons, is of opinion that they are a mixture of lime, extractive matter, oily or reſinous ſubſtances in ſome, and an aſtringent reſinous ſubſtance in others; ſometimes of a little calcareous ſalt, and ſometimes of a little ſilex or alumine.

As the obſervations and experiments on which he founds his opinion may, by laying aſide what he thinks unfavourable to oxygen, be exceedingly uſeful in the preparation of extracts, we refer to his memoir publiſhed in the *Annales de Chimie* for the year 7.

It reſults, from the moſt eſſential facts announced in the memoir of C. Deſchamps:

1ſt. That there exiſts, in the vegetable juices or decoctions which he ſubjected to examination, a neutral ſalt, the baſe of which has always been found to be lime, ſometimes mixed with a little ſilex and alumine, and of which the acid is often different.

2d. That this ſaline combination, not very energetic of itſelf, is weakened when diluted with water, and is eaſily deſtroyed by ebullition, like many others, when the acid in it is not in exceſs, while it maintains itſelf, and is not altered when the acid is ſuperabundant in it.

3d. That the decompoſition of this ſalt, when it takes place, is only momentary, ſince the depoſits become rediſſolved towards the end of the evaporation by the ſame acid which has abandoned them; and which then, notwithſtanding the loſs it has ſuſtained in its quantity, reſumes ſufficient force to re-eſtabliſh things nearly in their firſt ſtate.

Hence ariſes the neceſſity of not ſeparating depoſits which prevent acids from being acid and deliqueſcent.

4th. That theſe depoſits, the major part of which is lime, which carries with it, more or leſs combined, ſometimes an oily extractive, ſometimes a reſino-aſtringent ſubſtance, and ſometimes a little eſſential ſalt, itſelf not being decompoſed, do not take place when the juices are not diluted with water, when maceration and infuſion are ſubſtituted for ebullition, and when the evaporation is effected in a gentle heat.

By uniting the facts contained in the memoir of C. Deſchamps with the obſervations of the chemiſts above men-

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tioned, we may see how extracts must be prepared in general: but there is one which requires peculiar processes that must be made known.

1st. Robs of the elder and buckthorn are made with juices which have been extracted 24 hours before from the berries of these two shrubs.

During that time, these juices become charged with the extractive colouring part lodged under the skin of the berries, and by these means acquire more virtue.

2d. Extract of juniper is obtained by maceration of fresh juniper berries which have been bruised. They are evaporated in a gentle heat, after being made to pass through flannel.

It is saccharine and aromatic: it would be acrid and resinous, if ebullition were employed. Baumé, however, has prescribed it; but he made it light, and recommended not to bruise the berries.

3d. Extracts of cassia and tamarinds are all products of the maceration and pulp of these fruits.

Infusion of tamarinds, cold, is attended with the inconvenience of suffering their essential salt to be precipitated during the evaporation.

4th. Extract of the corn poppy is produced by carefully infusing the dried flowers.

5th. That obtained from saffron is very abundant; almost the whole of its stamina are converted into extract; so that it may be considered as useless to subject them to this preparation, which, altering their virtue a little, does not reduce them to a less volume.

6th. The extract of coloquintida is made with a decoction of the pulp of that fruit freed from the seeds. To render it sweeter, and make it less susceptible of griping the bowels, it ought to be deprived of its resin.

Baumé caused it to be redissolved in cold water. He filtrated the liquor, and the resin remained on the paper. This operation he repeated three times.

7th. Opium is brought to us from Turkey. The practice of making it near the ruins of Thebes has been lost. The inhabitants of Egypt still cultivate the plant which furnishes it; but only to eat the seeds, which they are fond of, as well as of all other emulsive seeds.

Opium is an extract prepared from the expressed juice of the leaves, stems, and heads of the white poppy.

That used in commerce is very impure. The preparer of opium dissolves it in water, makes the liquor pass through flannel,

flannel, and evaporates it in a balneum mariæ. When he wishes to make it more tranquillizing than narcotic, he subjects it to both the following preparations:

The first consists in cutting the opium into slices, boiling it in the quantity of water necessary to dissolve every thing soluble it contains, straining the liquor, evaporating it to a half, putting it into a tin cucurbit immersed in a sand bath over a fire maintained three months night and day, adding water in proportion as it is evaporated, scraping from time to time the bottom of the evaporating vessel, to prevent the resin which is precipitated from being burnt, straining the liquor when three months are elapsed, and then evaporating.

A solid extract, called opium, is obtained by long digestion of all the extracts of opium: this is the one most esteemed by Baumé. The second process is that employed by Josse to extract the gluten from the farina of wheat.

The opium is exposed under the cock of a vessel which produces only a small stream of water, where it is kneaded: its extractive matter is dissolved, and the resinous part remains in the hands; the liquor is then filtrated, and it is evaporated to the consistence of extract.

The third method of correcting opium is that recommended by Baumé for freeing the extract of coloquintida from the prejudicial resin which it contains, viz. solution, cold filtration, and evaporation. But as the resin of opium is more difficult to be removed than that of coloquintida, these three operations are repeated six times successively.

8th. It is customary to purify by solution and filtration extracts of the acacia, hypocistis, cachou, and liquorice, sold in the shops. But an exact pharmacopolist will prefer preparing the last-mentioned article himself from the liquorice of our gardens: he will treat it by infusion, and will thus obtain a brown extract of a sweet taste and very agreeable, while the other is black and acrid, and often contains charcoal and always copper, both taken from the bottom of the bason by scraping it with an iron spatula.

9th. Extract of senna ought to be made from an infusion of the leaves: strong decoction would add to the extractive substance given by infusion, a mucilaginous matter which would weaken its virtue.

10th. Extracts of hemlock, stramonium, hyoscyamus, and bella-dona, were prepared by Storck from the unpurified juices of these plants.

It is much better to evaporate these juices after they have been purified and mixed at the end of the baking, the green fecula being separated.

11th. The dry extracts of La Garaye are all made by fimple maceration evaporated in a balneum mariæ, or in a ftove, on flat difhes; they form very thin fcales.

La Garaye filtered his liquors a fecond time when they were half evaporated; but this fecond filtration is ufelefs if there exifts no depofit, and it is hurtful if there be one; becaufe in feparating it, inftead of fuffering it to be rediffolved, the extract acquires the property of attracting moifture more ftrongly.

The procefs employed by La Garaye for preparing his extracts alters as little as poffible the fubftances they contain.

12th. Extracts made from fuch frefh-gathered roots as contain mucous bodies in ftates of folution and of infolubility, that is to fay, mucilage, properly called ftarch, alfo have need, as already faid, of a preliminary preparation to make them lofe the latter fubftance, capable of becoming mouldy when by the aid of warm water it has affumed the ftate of jelly.

But this ftarch does not hurt extracts prepared with infufions or decoctions of the fame roots dried, becaufe the mucilage of the roots is deftroyed or modified by the deficcation.

13th. Several pharmacopolifts having obferved this change which deficcation produces in the ftate of the mucous part of plants, have thought that it would be of advantage to prepare extracts from dried plants, efpecially in regard to plants highly mucilaginous, fuch as burrage.

Experience has taught them that extracts more abundant, and which keep longer without alteration, may be obtained by this method.

Is the extractive principle increafed by deficcation at the expenfe of the mucilage, or does the mucilage by drying in the plants affume a ftate which approaches very near to that of extractive matter?

14th. There are fome extracts in which it is neceffary to retain a refino-gummy or extracto-refinous fubftance: this may be effected by fucceffively treating the plant which contains it with water and with alcohol. The refult of thefe two folutions, intimately mixed and properly concentrated, gives this kind of extract.

15th. Sometimes wine is employed in order to have only one infufion to make, and to fulfil the fame indication; but it is probable that the end propofed in this cafe is not obtained.

Wine, indeed, befides its not diffolving fo well the two required principles, is attended with the inconvenience of furnifhing not only the extractive fubftance proper to it, but

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also an acid, which must necessarily have a greater or less action on the extractive matter of the vegetables, change its nature, and increase in the extracts the tendency they have to deliquescence.

16th. Vinegar extracts very badly the principles of vegetables; it generally alters them, or is altered by them.

It may however be still employed as a solvent in regard to squills, garlic, resinous gums, and as a vehicle of the odours and colours of some flowers.

17th. Extracts by highly rectified alcohol are resins; by weak alcohol they are resins mixed with gummy or extractive substances.

Vegetable substances subjected to the action of alcohol are dry, and much divided: this action is assisted by a degree of heat more or less considerable. The vessel in which the operation is performed must be sufficiently large to allow the vapours to circulate.

When the solution has been made and filtered, water is poured over it, and the alcohol abandons the resin to unite with the water; or it is subjected to distillation, and the alcohol passes off in vapours, leaving the resin free in the same manner.

18th. If jalap, for example, has been employed, to obtain the resin, and if it be intended to procure the gummy extract of this root, the exhausted residuum of the resin must be treated with water, after which the infusion is filtered and evaporated.

It results from these general considerations on vegetable extracts, that the pharmacopolist, if he proceeds methodically, will always have the satisfaction of furnishing the healing art with medicines containing the whole of the immediate products of vegetables, and consequently susceptible of producing the effects which essentially belong to them.

XII. *Description of a Three-blast Fusing Furnace, constructed in the Chemical Laboratory of the French School of Mines. By* P. Torelli-Narci, *attached to the Council of Mines.*

THIS furnace is destined for fusing different mineral substances, in order to ascertain the nature of them; and the experience of six years has shown that it answers the intended purpose. By its means a very intense heat is obtained, and it was employed by C. Clouet for repeating his experiments on

on the conversion of forged iron into cast steel, which were attended with full success.

Chemists who have seen this furnace seemed desirous of being better acquainted with the construction of it: the council even transmitted drawings of it to several persons; and what has hitherto prevented a description of it from being given was a desire to ascertain its power by longer use.

I long ago conceived the idea of a fusing furnace, in which the wind was distributed in three tuyeres placed in its circumference, and at equal distances from each other; but I had no opportunity of realizing this idea till I became attached to the council of mines.

Nearly seven years ago a plan was in agitation for constructing in the laboratory of the school a fusing furnace capable of producing a very great degree of heat, in order to operate with facility and speed on larger quantities of mineral, and consequently to obtain more precision in the trials which might be made than had been obtained by the small furnaces before employed for docimastic experiments.

I proposed my ideas: they were approved by the council of mines; and I was ordered to cause the furnace I am about to describe to be constructed. The principal difference between it and those before used for the same purpose is, that in the present one the wind is introduced through three tuyeres, placed at equal distances from each other in its circumference, whereas in common furnaces it enters only by one.

This furnace is round, both outside and inside, and constructed of very refractory bricks, secured by iron hoops in such a manner that they cannot be displaced. It rests on a square base of strong mason-work, raised to a sufficient height above the ground to render it easy to manage.

The bellows are four feet in length, and the mean breadth of them is about 20 or 21 inches: they are of wood, and the joints are covered with white leather. The upper part consists of five folds and two half folds; the inferior, of two folds and two half folds. They are placed 8 or 9 feet* above a wooden box, the joints of which are covered with leather, and into which the wind as it comes from the bellows is conveyed by a copper pipe, three inches in diameter, adjusted to the upper part of the box. The box itself is supported by two iron bars built into the wall. From the lower part of this box descend, in a vertical direction, three pipes

* This height is arbitrary; it depends in part on the manner in which the bellows are disposed, and on the height of the chamber in which the furnace is placed.

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of copper, two inches in diameter, bent at right angles about 45 inches below it, to bring them into a horizontal position, and to convey the wind to the furnace, which is about six feet distant. The extremities of these pipes are fitted into three tuyeres of forged iron, fixed at equal distances around the circumference of the furnace: these three pipes are more or less curved or bent, to convey the wind into the furnace by the three apertures made for that purpose.

About six inches below the box is adjusted, on each of the three tubes, which descend in a vertical direction, a brass cock about three inches of interior diameter: these cocks serve to intercept entirely the communication between the bellows and the furnace; and by opening them all more or less, or each of them separately, any required quantity of wind may be obtained *.

These cocks are well fixed to the tubes, and kept in their place by two clips of iron suited to the diameters of the tubes, and forming a kind of three collars, which by means of four screws embrace and confine them: these pieces of iron are themselves made fast to two crutches of iron, which support the box and are fixed to it by screws. The box is kept on the crutches by two straps, which embrace it at each extremity, and are fixed by female screws, which are fitted to screws on the ends of these straps after they have passed through the horizontal part of the two crutches.

To give the proper strength to this furnace, a solid square was constructed of mason-work, about a foot larger on each side than the exterior diameter of the sides of the furnace, which were from 21 to 22 inches from outside to outside. Bricks were placed on the ground in the middle of this erection for the extent of 18 inches, in order to form a bottom, and on this base were placed the sides of the furnace constructed in the manner about to be described.

I caused to be forged two iron hoops six lines in thickness, from 2 to $2\frac{1}{2}$ inches in breadth, and about 22 inches of exterior diameter: these two circles were fastened together by three bars of iron, the distance of their exterior edge being

* Care must be taken, when the action of the bellows ceases, to shut the cocks, especially when coals are used in the furnace; for the hydrogen disengaged from that mineral substance ascends into the box, and, when the bellows are again made to act, may inflame, and cause a violent explosion, or even burst the bellows. This accident once took place in the furnace here described: the box burst with a loud noise on the first stroke of the bellows, the gas which filled them having suddenly inflamed; but by good fortune no person was hurt. The same thing happened at the house of C. Gorlier, locksmith, of Paris: one of his bellows burst with a horrid explosion at the moment when they were put in motion.

kept at about nine inches, the height of the bricks: these bars are pierced with holes towards the end riveted on the circles, and placed at equal distances on their circumference. One of the extremes of each of these three bars is left of a sufficient length to pass beyond the lower circle about an inch, in order to make them enter into three holes formed in the brick-work which forms the bottom of the furnace, and by these means to prevent the furnace from becoming deranged.

This kind of iron frame was filled with bricks similar to those employed for the bottom of the furnace: they were rubbed one on the other to smooth them, and the corners were a little rounded; so that, being placed upright with their broad sides applied to the iron hoops, the narrow side stood inwards. By these means all these bricks were adjusted in such a manner as to touch each other by their broadest faces, and to form the sides of the furnace, the thickness of which was equal to the breadth of the bricks, and its depth to their length. Three apertures were reserved for the tuyeres which terminate the three tubes that convey the wind, by cutting from as many bricks a portion equal to the thickness of a brick.

These bricks thus adjusted were taken from the iron frame, and then replaced, putting between them a cement to connect them firmly and to fill up the joints. The dust produced by cutting the bricks was reserved for this purpose; and I desired the workman to mix with it a small quantity of clay diluted in a great deal of water, in order to make a puddle for daubing over the bricks, and in particular to put between them no more than was necessary for filling the joints and the small space left between their faces in consequence of any inequality left in dressing them.

The furnace thus constructed was then placed on its base, a stratum of the same mortar employed for filling up the joinings of the bricks being first interposed. The extremities of the three iron bars projecting beyond the lower circle were placed in the holes left in the base to receive them. The body of the furnace encircled with iron, both by its weight and the gentle blows given to the iron hoops above the bars which connected them, expelled the excess of the mortar, and caused a part of it to enter and unite with that which filled up the joints of the brick-work of the circumference, which rendered it immoveable.

The bellows is secured as usual by crutches of iron and supporters fixed in the wall and to the floor: the handle is disposed in such a manner, that the rope which makes it act

may be pulled by the ſame perſon who manages the fire of the furnace, which in certain caſes is neceſſary.

The tuyeres of forged iron which receive the ends of the copper tubes are ſecured in their proper apertures in the circumference of the furnace by pieces of brick and mortar ſimilar to that employed for filling up the joints; and the ends of the copper pipes introduced into theſe tuyeres are luted with the ſame mortar, a little thickened with brick-duſt.

The aperture of theſe tuyeres towards the interior of the furnace is only nine lines in diameter; on which account, as the volume of air furniſhed by the bellows cannot paſs ſo quick as it is produced, it becomes condenſed in the box placed above the cocks. By theſe means a very uniform blaſt is obtained, which can alſo be regulated by opening more or fewer of the cocks.

During more than ſix years, ſince this furnace was conſtructed, it has ſuffered no derangement: it is not even cracked. It is however worn in the inſide by the violence of the heat it has experienced, which has increaſed its diameter about two inches. The parts round the three tuyeres have alſo got hollowed, ſo that it has need of being repaired. It is intended to make it deeper, and to have a kind of moveable muffs or linings made of fire-clay, in order that its diameter may be reduced at pleaſure: it is meant alſo to conſtruct it in ſuch a manner, as to depoſit the reſt or ſupport for the crucible, not on the bottom of the furnace, but on bars of forged iron placed at the diſtance of ſome inches from that bottom, ſo as to leave below them a vacuity in which the blaſt of the bellows may be diffuſed, and from which it may riſe, paſſing between the bars to traverſe the maſs of charcoal which ſurrounds the crucible. The blaſt will then produce a more uniform fire, and the flame can no longer be directed againſt the ſides of the crucibles; ſo that the riſk of their breaking by ſudden inequalities in the heat will be much leſs.

This alteration is going to be immediately carried into execution, and the method propoſed for doing it is as follows:

A round frame will be made of forged iron, in which bricks will be placed in the ſame manner as above deſcribed. In the lower part of the furnace an aperture will be reſerved for raking out the aſhes, which will be cloſed by means of a door of baked earth carefully luted with clay. Some inches above the bottom of the furnace will be placed a grate of forged iron, and between this grate and the bottom of the furnace the tuyeres will terminate, and the blaſt be introduced. Muffs or linings of very refractory earth will then be

be introduced, fo as to defcend to this grate. There will be two of them, one within the other, and both within the body of the furnace. At the lower part thefe muffs will be furnifhed with a rim, projecting outward fo as to leave between the body of the furnace and the muffs a vacuity, which will be luted at the bottom with clay, and which will be filled with pounded glafs, or any other fubftance a bad conductor of heat.

The interior muff, or both of them, may be removed at pleafure to obtain a furnace of greater or lefs capacity according to the operations to be performed. It is propofed to make the muffs wider at the top than at the bottom.

Explanation of the Figures (Plate I.).

Fig. 1. Plan of the bellows and of the furnace. A B, the bellows made of wood, the folds of which are alfo of wood covered with leather on the joints. C D, the handle which ferves for moving the bellows. E, a copper tube which conveys the wind of the bellows into the box F G, in which it is condenfed. F G, a box of wood ferving as a refervoir for the wind condenfed by the bellows. H I, K L, M N, three pipes adapted to the box F G, and which convey the wind into the infide of the furnace by three tuyeres, I, L, N. O P, mafon-work to fupport the horizontal pipes. Q, the furnace properly fo called, the form of which is circular, and which is placed on the fquare mafon-work R, S, T, U.

Fig. 2. Elevation of the furnace, the pipes which convey the blaft, the cocks, the condenfing box, and the bellows. AB, the bellows mounted in their place, and fupported by the iron-work neceffary for fecuring it, which is fixed in the wall and to the floor. CD, the handle which ferves for moving the bellows. E, the copper pipe which conveys the blaft of the bellows to the box F G in which it is condenfed. At G is a hole fhut by a large cork ftopper, which can be opened at pleafure. This box is fupported by two crutches of iron *f*, *g*, and *h*, *i*, built into the wall, and on which it is fixed by two iron ftirrups *l*, *m*.

Fig. 3. One of the crutches and its ftirrup are feen reprefented fidewife at *f*, *g*, *l*; the extremities, *n*, *o*, are built into the wall, and the two ends, *p*, *q*, of the iron piece which keeps the box on the horizontal traverfe of the crutch, are tapped, and receive fcrews which make them faft to the crutch *f*, *g*. H I, K L, M N, are three pipes which convey the wind into the interior of the furnace. Q, R, S, T, U, mafon-work on which is placed the furnace Q, and which

ferves

serves it as a bottom. OP, masonry which serves to support the three pipes that convey the wind to the furnace. XYZ, fig. 2. are the three cocks fixed to the three pipes which proceed from the box to convey the wind to the furnace.

In fig. 4., the dimensions of which are double those of fig. 2., may be seen the details of one of these cocks.

At *r, s, t,* the body of the cock is seen in front; the stopper being taken out shows at *r* and at *t* the two holes which receive the tubes that communicate either with the box or with the tuyeres. *u* exhibits the body of the cock seen on one side; *v* the key with its aperture *x*, and its head *y*. This key, turned round more or less in its socket, serves to give more or less wind. 1, 2, 3, iron clips which secure the cocks at the distance they ought to be from each other, and connect them at the same time to the iron crutches which support the air-box.

Fig. 5. a plan of these two clips. They are bent at the places marked 1, 2, 3, to embrace the body of the three cocks, and secure them in such a manner that they cannot be deranged when they are opened or shut.

Fig. 6 and 7 represent the plane and section of the changes and additions proposed to be made when the furnace is reconstructed. At I, L, and N, are seen the extremities of the three pipes that enter the forged iron tuyeres, and convey the wind to the interior of the furnace. *a, b,* and *c,* indicate the thickness at the upper part of each of the muffs and of the body of the furnace, between which there are two vacuities filled with pounded glass or some other bad conductor of heat. *d*, the grate on which are deposited the rests of baked earth destined to receive the crucibles. *e*, the crucible, luted and attached with clay to a rest of baked earth.

Note by the Author on the Furnaces which have several Tuyeres.

The advantage arising in large founderies from the application of two or three tuyeres instead of one, is well known; but I do not believe that such an arrangement was ever adopted in small furnaces.

At Treibach, in Carinthia, C. Le Febre, and Hassenfratz member of the council and inspector of mines, saw, about twenty years ago, a large furnace with two tuyeres; drawings of which they brought to France, and which they represented in the third plate of *l'Art de fabriquer les Canons*, by Monge: two pairs of bellows supply wind through two opposite tuyeres, and since that arrangement the daily product of metal has been double.

In

In England, Mr. Wilkinfon has employed feveral years, for fufing iron ore by coke, furnaces of lefs height than thofe which he ufed before, and he fupplies wind by three tuyeres placed at equal diftances in the circumference of the furnace.

XIII. *On a metallic Solution, which forms a Yellow Ink, that appears and difappears like that of Hellot. Read before the French National Inftitute, by* C. Gillet-Laumont, *Affociate**.

SOME time ago, having thrown into the fire a folution of a mixture of fulphate of copper and muriate of ammonia, where it produced very agreeable colours, fome of it fell upon a piece of paper placed in the chimney, which became of a bright yellow colour. Having taken the paper from the chimney, I was much aftonifhed, fome moments after, to find that it was no longer coloured: on again expofing it to heat the colour reappeared, and difappeared in like manner on cooling.

I tried lately to repeat this experiment; and I obtained from thefe two falts, mixed nearly in equal parts, a folution of a bright yellow colour when warm, and of a beautiful emerald green when cold, which at firft gave cryftals in oblique prifms with rhomboidal bafes, and then blue cryftals in flat octaedra.

This liquor and the folution of the cryftals gave a yellow ink, which appeared yellow with heat, and difappeared with cold, but ftill better with moifture.

I obferved that thefe folutions are indebted for this property only to the muriate of copper, which when employed alone does not produce the fame effect.

On comparing this ink with that given by the muriate of cobalt, known under the name of the fympathetic ink of Hellot, it is feen that all thefe kinds of ink are indebted for the property which they have of difappearing, only to metallic muriates, which powerfully attract the moifture of furrounding bodies.

The yellow ink produced by the muriate of copper and the folutions which contain it (very different from thofe which, being at firft invifible, remain fixed after they have appeared) gives by its colour a variety very diftinct from that of Hellot, which is of a fea green: with the latter it forms varied tints of an emerald green.

* From the *Journal des Mines*, No. 58.

They

They may be made to appear at pleaſure by the aid of heat, and to diſappear very ſpeedily by putting the writing between the folds of paper ſomewhat moiſt: but I muſt here obſerve, that it requires much care to make the experiment ſucceed completely, and that a certain degree of heat muſt not be exceeded; otherwiſe, the paper being ſcorched, the writing can no longer diſappear.

XIV. *A ſhort View of the Craniognomic Syſtem of Dr.* Gall, *of Vienna. By* L. Bojanus, *M. D. Member of the Medical Societies of Jena and Paris, and of the Society of the Obſervers of Man* *.

At all periods, a deſire to find in the exterior of man certain marks indicative of his interior faculties, his paſſions, his morals, &c., has induced the learned to eſtabliſh ſyſtems of phyſiognomy more or leſs ſatisfactory. The moſt ſtriking of theſe ſyſtems are thoſe of Baptiſta Porta and Lavater, the theory of the facial angle, and the ſyſtem of Dr. Gall.

In regard to the firſt, who employed himſelf in comparing the contours of the human figure with thoſe of beaſts, obſervers have determined its value, and conſider his principles as the fruit of a diſordered imagination, as too bold, too little founded on rational obſervation, and abſolutely uncertain in its application.

The ſyſtem of Lavater has had more ſucceſs; but while we revere the genius of that celebrated man, who was truly a great obſerver, we cannot help acknowledging the inſtability of the baſis on which all the opinions he advances reſt; and the mind is not ſatisfied with truths which can be appreciated only by an imagination equally exalted, and a touch ſo delicate as that of the author.

The theory of the facial angle, which embraces a wider field than the ſyſtem of Lavater, leaves us in uncertainty reſpecting the detail of the faculties, and gives us only general points of view; but it preſents us with this truth, of the greateſt importance—that the facial angle increaſes in ſize in proportion to the faculties of animals: and in this it coincides

* From the *Magazin Encyclopédique*, No. 4, Meſſidor, an. 10. Dr. Bojanus in a note ſays: "As this hiſtorical explanation is by no means intended to prove the truth of Dr. Gall's ſyſtem, it can lead to no deciſive opinion on this ſyſtem, which will be eſtabliſhed by its author on ſolid reaſoning and convincing teſtimony. It is neceſſary alſo (ſays he) to obſerve, that the paſſages marked with inverted commas do not reſt on the authority of Dr. Gall."

in an evident manner with the general reſults of the ſyſtem of Dr. Gall.

Without entering into an exact detail of the laborious route which this learned philoſopher purſued, to be enabled to eſtabliſh a certain baſis in a ſcience hitherto hypothetical, we ſhall examine briefly his fundamental principles.

1. *The Brain is the material Organ of the internal Faculties.*

Far from attempting to decide the metaphyſical queſtions on the nature of the ſoul, or what may be ſuppoſed as the occult cauſe of the internal faculties, we are, however, forced to admit a material organ for their action.

But, as it is obſerved that theſe faculties are found only where the brain exiſts; that they are loſt with it; that diſeaſe and læſion of the brain have a ſenſible influence on their degree and their action; that the volume of the brain increaſes in direct proportion to the faculties of animals; it is not venturing too far to conſider the brain as the material and intermediate organ.

[It might be here objected, that in ſeveral caſes individuals have loſt a conſiderable portion of the ſubſtance of the brain without the faculties being ſenſibly diminiſhed; but it is to be obſerved that the greater part of the cerebral organs exiſt double, and that the obſervations mentioned are not exact.]

2. *The Brain contains different Organs independent on each other for the different Faculties* *.

The internal faculties do not always exiſt in the ſame proportion to each other. There are ſome men who have a great deal of genius without having a memory, who have courage without circumſpection, and who poſſeſs a metaphyſical ſpirit without being good obſervers.

Beſides, the phænomena of dreaming, of ſomnambuliſm, of delirium, &c. prove to us that the internal faculties do not always act together; that there is often a very great activity of one, while the reſt are not ſenſible.

Thus in old age, and ſometimes in diſeaſe, ſuch, for example, as madneſs, ſeveral faculties are loſt, while others ſubſiſt: beſides, a continued employment of the ſame faculty ſenſibly diminiſhes its energy: if we employ another, we find it has all the force of which it is ſuſceptible; and if we return to the former faculty, it is obſerved that it has reſumed

* This idea of independence ought not to deſtroy that principle of animal organiſm, that all the parts are in a reciprocal ratio: it ought to mark only, that the action of one organ does not abſolutely imply the ſame degree in another.

its ufual vigour. It is thus that, when fatigued with reading an abftract philofophical work, we proceed with pleafure to a poetical one, and then refume with the fame attention our former occupation.

All thefe phænomena prove that the faculties are diftinct and independent of each other, and we are inclined to believe that the cafe is the fame with their material organs.

[We do not entirely agree with this idea of Dr. Gall, and we believe, on the contrary, that the feparation of the material organs ought to be confidered as the caufe of the diftinction of the internal faculties. It appears, to us at leaft, that by fuppofing the faculties themfelves as originally feparated we cannot fave ourfelves from falling into materialifm, which exifts when the mind is no longer confidered as unity.]

3. *The Expanfion of the Organs contained in the Cranium is in the direct Ratio of the Force of their correfponding Faculties.*

This principle, dictated by analogy, refts on this axiom, that throughout all nature the faculties are always found to be proportioned to their relative organs; and the truth of it is proved in a fpecial manner by the particular obfervations of Dr. Gall.

It is however to be remarked, that exercife has a great influence on the force of the faculties, and that an organ moderately expanded, but often exercifed, can give a faculty fuperior to that which accompanies a very extenfive organ never put in action; as we fee that a man of a weak conformation acquires, by continued exercife, ftrength fuperior to another of a more athletic ftructure.

[We muft here mention an opinion which feems to refult immediately from this principle, and which, however, is falfe: it is, that the volume of the brain, in general, is in the direct ratio of the energy of its faculties. Obfervation has proved to Dr. Gall, that we cannot judge of the ftrength of the faculties but by the development of the feparate organs which form diftinct eminences in the cranium; and that a cranium perfectly round, of whatever fize it may be, is never a proof of many or of great faculties.]

I do not recollect to have heard the reafon affigned by Dr. Gall, but, in my opinion, thefe brains may be confidered as in a ftate analogous to obefity; and as we do not judge of the mufcular force of a man or an animal by the volume of their members, but by the development of the mufcles in particular, I think we ought, in like manner, to judge of the

5 ftrength

ſtrength of the faculties by the development of the relative organs.

In the laſt place, the 4th principle, the moſt important for practice in regard to the ſyſtem of Dr. Gall, is:

We may judge of theſe different organs and of their faculties by the exterior form of the cranium.

The truth of this principle is founded upon another, viz. that the conformation of the cranium depends on that of the brain; a truth generally acknowledged, and proved by the anterior part of the brain, by the impreſſions in the anterior part of the cranium, and by other facts.

[There are ſkulls, it is true, in which an external protuberance of the bone correſponds to an interior one; and this irregularity, which is found ſometimes as a diſeaſe, and moſt commonly at an advanced age, when the cerebral organs do not oppoſe the ſame reſiſtance to the cranium, renders the practice of Dr. Gall's ſyſtem, in ſome meaſure, uncertain.]

Guided by theſe principles, Dr. Gall examines the nature of the ſkull, compares the crania of animals and thoſe of men analogous and different in faculties. His reſearches have proved to him, in a manner almoſt inconteſtable, not only the above truths, but that the faculties of animals are analogous to thoſe of man; that what we call inſtinct in animals is found alſo in the latter, ſuch as attachment, cunning, circumſpection, courage, &c.; that the quantity of the organs fixes the difference of the genus of animals, their reciprocal proportion that of individuals; that the diſpoſition originally given to each faculty by nature may be called forth by exerciſe and favourable circumſtances, and ſometimes by diſeaſe, but that it never can be created in the caſe where it has not been given by nature*; that the accumulation of the organs takes place in a conſtant manner from the hind part forwards, from the bottom to the top, in ſuch a manner, that animals in proportion as they approach man in the quantity of their faculties have the ſuperior and anterior part of the brain more expanded; and, in the laſt place, that in the moſt perfect animal, man, there are organs in the anterior and ſuperior parts of the frontal bone, and of the parietals, deſtined for faculties which belong to them excluſively. "It is under the latter point of view that the diſcoveries of Dr. Gall agree perfectly with the theory of the facial angle, which ſeems ſtill further to eſtabliſh the truth of them."

In regard to the details of Dr. Gall's ſyſtem, and the enu-

* The germ of every organ muſt exiſt in embryo, if the expanſion of that organ is to be afterwards called forth.

meration

meration of the different organs which he found, it is difficult to give an exact and satisfactory description of them, when illustrated with the number of facts and examples which he employs to prove, in an evident manner, what he advances; I shall however attempt the enumeration, being persuaded that it will contain several illustrations of the author's manner of considering the subject, and give a true idea of the method to be pursued to attain to his results *.

1. *Organ of the Tenacity of Life.*

The first organ which the author thinks he has found is that of the *tenacity of life* (*tenacitas vitæ*): he considers the medulla oblongata as the seat of it; and as the circumference of the large occipital foramen is in the direct ratio of the extent of the medulla oblongata, he employs the size of this hole to judge of the intensity of the life of an animal.

The observations which serve to support this opinion are, that this hole is generally larger in the crania of women than those of men; that it is constantly large in the cat, the otter, the beaver, the badger, &c., animals well known to have a very tenacious life. Besides, there are no speedier means of killing an animal than to cut the medulla oblongata.

2. *Organ of the Instinct of Self-preservation.*

A little further forward in the medulla oblongata, at the place where it leaves the brain, the author places the *organ of the love of life*, or *of the instinct of self-preservation.*

As animals furnish no instances of suicide, it was only from the human race he could procure examples in favour of this position; and several cases of suicide, in which this part of the brain was diseased, determined him to consider it as the organ of that faculty: he does not, however, consider it as an absolute truth; he waits for further examples to serve as proofs.

3. *Organ for the Choice of Nourishment.*

The organs for the choice of nourishment are found, according to the author, in the quadrigemini tubercles; the anterior of which are larger in carnivorous animals, the posterior more expanded in graminivorous, and which in omnivorous are of equal size.

4. *Cerebral Organs of the external Senses.*

The middle part of the base of the brain is destined to the

* Compare the different articles with the corresponding numbers in the figure, Pl. II.

external ſenſes. This is the region from which the nerves diſtributed to the organs of theſe ſenſes proceed.

5. *The Organ of Inſtinct and Copulation.*

The *organ of inſtinct and copulation* is ſituated at the baſe of the occipital bone, behind the medulla oblongata and the large occipital foramen.

This organ never expands but at the age of puberty, and its increaſe has a great influence on the form of the nape of the neck, becauſe to this part of the cranium its muſcles are affixed.

In animals caſtrated before the age of puberty, the expanſion of this organ does not take place. It is certain that the bull has the cheſt much broader than the ox, and that "horſes ſubjected to caſtration before their cheſt is full have that part always ſlender."

In the ape, the hare, and cock, this organ is very apparent; and in pigeons and ſparrows the occipital forms a particular bag, which ſeems to be an appendage of the head; and it is well known that theſe animals are exceedingly ardent in copulation. The ſame diſpoſition is ſometimes found in the cranium of man; and Dr. Gall has in his collection the ſkulls of ſeveral fools, who were diſtinguiſhed by their laſciviouſneſs, and whoſe occipital bone preſents an enormous projection.

6. *Organ of the reciprocal Love of Parents and Children.*

The organ of the reciprocal love of parents and children occupies the whole poſterior and ſuperior part of the occipital: by its poſition it is intimately connected with the preceding organ, the action of which muſt neceſſarily have an influence upon it. "Sometimes its exceſſive expanſion contributes to produce that prolongation of the occipital in the form of a bag, mentioned in the preceding article."

This organ in general is more ſtriking in women than in men, and throughout all nature more ſo in the female than in the male ſex: it is very apparent, in particular, among apes, whoſe love for their young is ſo well known that it has become proverbial.

"In general, all animals which ſhow a great deal of attachment to their young are provided with it; and it appears to us that pigeons, the male and female of which both ſit on the eggs, and which feed their young by a ſort of rumination, may be given as an example."

The cuckow, which never rears its young, is almoſt entirely deſtitute of this organ.

7. *Organ*

7. *Organ of Attachment and Friendſhip.*

At the poſterior and middle part of the parietals, and the lateral part of the occipital, is the organ of attachment or friendſhip.

"Its poſition brings it into intimate connection with the two preceding organs, and it appears that theſe organs have an action together, eſpecially in animals deſtined to live in ſociety."

Dogs ſhow the moſt ſurpriſing marks of attachment; and the inſtances are furniſhed chiefly by the barbets, baſſets, and houſe-dogs. Theſe ſpecies, therefore, are diſtinguiſhed by a large head, on which is found the expanſion of this organ behind and above the zygomatic apophyſis. The gre-hound, which is the leaſt ſuſceptible of attachment, has the head narrower behind, and in general is deſtitute of this organ.

8. *Organ of Courage.*

It is the poſterior and inferior angle of the parietal that correſponds to the angle of courage. It contributes to enlarge the ſize of the head, and to ſeparate the ears from each other. Its proximity to the three preceding organs explains to us the fury of animals in rutting-time, and the exceſs of courage in thoſe which have young, or which protect the female and the individuals of their ſociety.

It is very ſtriking in the hyæna, the lion, the wolf, ſome ſpecies of dogs, and particularly in the wild boar, the temerity of which is well known.

On the other hand, the aſs, the gre-hound, the ſheep, and the hare, which are diſtinguiſhed by their timidity, are entirely deſtitute of this organ: their head is ſtraight poſteriorly, and their ears are very near to each other.

A very ſurpriſing phænomenon ſeems to ſupport the opinion of Dr. Gall on the ſeat of this organ: it is a certain involuntary motion of man when he loſes courage. He ſcratches behind his ears, as if deſirous to excite the action of the organ which gives him that faculty.

[We have remarked a movement in cats which appears to have ſome reſemblance to the above, and which relates to the organ of attachment. When fawning on man, they always preſent the poſterior part of the head to rub it againſt him.]

9. *Organ of the Inſtinct to aſſaſſinate.*

Before the organ of courage, towards the middle of the lateral part of the parietals, reſides the organ of the inſtinct to aſſaſſinate,

It appears in all carnivorous animals which live on prey. Dr. Gall found it in the crania of ſeveral aſſaſſins who had been executed.

10. *Unknown Organs.*

Two organs which correſpond to the temporal bone are as yet unknown in regard to their functions.

11. *Organ of Cunning.*

The organ of cunning occupies the anterior and inferior part of the parietals: it appears in all animals diſtinguiſhed by that faculty; ſuch as the fox, polecat, domeſtic cat, the diver *, and is in intimate connection with the *organ of theft*, which conſtitutes a prolongation of it towards the orbit, and which is found in the cat, ſome dogs, and the magpie.

It is, perhaps, to the development of this organ that we ought to aſcribe the great width in the heads of the Calmoucs, among whom a propenſity to thieving is a national characteriſtic.

12. *Organ of Circumſpection.*

The organ of circumſpection is found in the middle of the parietals, above the organ of cunning and that of the inſtinct of aſſaſſination.

The exceſſive development of it produces irreſolution; want of it, ſtupidity: it is very ſtriking in the chamois goat, and roe-buck, the circumſpection of which is ſingular, and which never travel on an unknown road without great precaution.

It is found alſo in animals which do not quit their habitations but in the night-time, ſuch as the owl, otter, &c.

[To be continued.]

XV. *Proceedings of Learned Societies.*

ROYAL ACADEMY OF SCIENCES, BERLIN.

THIS Academy has propoſed the following as ſubjects for

Prize Queſtions:

I. The Mathematical Claſs offers a triple prize for the beſt diſſertation on the obliquity of the ecliptic.

Papers on this ſubject will be received till the 1ſt of May 1806.

* One obſervation difficult to be arranged is, that Dr. Gall always found this organ developed in poets: he gives no explanation, but his obſervation is correct.

II. The

II. The Clafs of the Belles Lettres has again propofed the queftion refpecting the Goths and Gothicifm, with the following variations and definitions, and offers a double prize.

1ft. Did the northern tribes, the Goths, Vandals, Suevi, Longobardi, Franks, Burgundians, Anglo-Saxons, &c., who divided the weftern poffeffions among them, bring with them from their own country any thing peculiar in their arts and fciences? or, Cannot it be rather proved that every kind of mental culture which thefe people acquired was obtained from their intercourfe with the old inhabitants of the Roman empire, and from their being mixed with them by their conquefts?

2d. Ought we therefore to afcribe to thefe people a peculiar ftyle in their literature and arts? or, Are the fpecimens of thefe arts which occur in the middle ages only modifications of the antient Greek ftyle, produced after the decline of the Roman empire by the new political, religious, and moral fituation of thefe people?

3d. And, if the latter be the cafe, what are the diftinguifhing marks of the productions of the middle ages in literature and the fine arts? What is the proper order in which they follow each other? What influence had the cultivation of the fine arts among the Arabs on thofe of the weftern part of Europe? When and through what channels was this influence perceptible, and by what figns was it diftinguifhed?

Papers on this fubject will be received till the 1ft of May 1804.

III. The following is the queftion propofed by the Phyfical Clafs:—Has electricity any influence on matters in a ftate of fermentation? Does it contribute to, or impede, fermentation? Does it produce any change in the products of fermentation? What advantage can be derived from calling forth this matter in order to improve the art of preparing wine, beer, vinegar, and brandy?

Papers on this fubject will be received till the 1ft of May 1803.

IV. The following is the queftion propofed by the Philofophical Clafs:—Is the moral worth of an action to be taken into confideration in the application of a criminal law? And if this be the cafe, how far can it be done?

Papers on this fubject will be received till the 1ft of May 1803.

ACADEMY OF THE USEFUL SCIENCES, ERFURT.

The queſtion propoſed laſt year, which has not yet been anſwered, is again put by the Academy as

A Prize Queſtion:

What uſeful application can be made in chemiſtry of the temperature below zero of Reaumur's thermometer; and how far is it poſſible, by artificial means, to lower the temperature?

The prize for the beſt anſwer is thirty ducats, and papers will be received till the end of July 1803.

FRENCH NATIONAL INSTITUTE.

Prize Queſtions.

The Claſs of the Moral and Political Sciences has propoſed the following queſtion as the ſubject of a prize:

To determine how the faculty of thinking ought to be decompoſed, and what are its elementary faculties?

The prize will be a gold medal of the weight of five hectogrammes (about 70l. ſterling), and will be decreed in the public ſitting of Germinal, year 12 of the republic. Papers will be received only to the 15th of Nivoſe the ſame year.

The Claſs of the Moral and Political Sciences propoſed in the year 9, as the ſubject for a prize in geography, the following queſtion:

To compare the geographical knowledge of Ptolemy reſpecting the interior of Africa with that which has been tranſmitted to us by later geographers and hiſtorians, except in regard to Egypt and the coaſts of Barbary from Tunis to Morocco?

As the papers tranſmitted to the claſs did not anſwer the conditions, the claſs propoſes the ſame queſtion as the ſubject of a prize for the year 11.

The prize will be a gold medal of the ſame value as the former, and will be adjudged in the public ſitting of Meſſidor, year 12. The period for receiving papers the ſame as above.

In the ſitting of Germinal 15, year 8, the Claſs of the Mathematical and Philoſophical Sciences propoſed as the ſubject of a prize the following queſtion:

To determine, by anatomical and chemical obſervations and experiments, what are the phænomena of the torpor which certain animals, ſuch as the marmot, dormouſe, &c. experience during winter in regard to the circulation of the blood, reſpiration, and irritability; to determine what are the cauſes of this ſleep, and why peculiar to theſe animals.

The

The class was of opinion that neither of the two memoirs transmitted to it contained a sufficient illustration of the subject to be entitled to the prize, but that the observations in them were sufficiently interesting to deserve honourable mention. The author of the memoir No. 1, with the motto *Incerta facies inter vitam et mortem*, does not explain the necessary distinctions between the ways in which the different classes of animals spend the winter, and does not give sufficient details in regard to their peculiar habits and the differences in their manner of life. He speaks only of some of the mammalia; but he gives anatomical details respecting the diaphragmatic nerves, and those known under the name of nerves of the eighth pair, as well as the thymic gland, and the muscles which serve to determine the form which the animal assumes during its torpor. He gives also some curious observations on the degree of temperature into which the animal enters when in that state: it was chiefly on the *mus avellanarius*; the bat, *vespertilio murinus*; the hedge-hog, *erinaceus europæus*; and the marmot, *arctomys marmotta*, that these observations were made.

One-half of the memoir No. 2, having the motto *Quid mirum si non ascendunt in altum ardua aggressi?* is devoted to general observations on life and death, and on the different modifications of life. Without considering these preliminary observations foreign to the object which the author proposes, in our opinion he has given them too much extent. He then makes a distinction between animals which pass the winter in a state of torpor. He separates those whose torpor is properly a deep and prolonged sleep, which he calls *vita soporosa*, from those whose torpor is a real suspension of the vital functions, which he calls *vita interrupta*. Among the former he examines the bear, *ursus arctos*; the hedge-hog, the bat, the marmot, the dormouse, *myoxus glis* Schreber.; the wood-rat or muscardin, *myoxus muscardinus* Schreber.; and the hamster, *mus cricetus* Linn. He enlarges a great deal on their habits, their kind of life, and the manner in which they pass their state of torpor; but gives few details in regard to their anatomy. He however observes, as the author of the former, the size of the diaphragmatic nerves and the eight trisplanchnic pair, particularly in bats, but does not speak of the state of the thymus. Among animals of the second he distinguishes those which are provided with organs of circulation, as the amphibia, and those which have no apparent organs of that kind, as is the case with insects; but of the amphibia he examines only frogs, and gives no details respecting the torpor of insects. His observations on the frog

 are

are very extenfive: he fupports them by very curious obfervations on the refpiration of that animal; the ftructure of the organs which ferve for that purpofe; the properties he afcribes to the fkin of thefe animals; the caufes which make them move during the time of their perfect life, and thofe which preferve them during their ftate of torpor.

We invite the authors to give more extent to thofe parts of their labour on which they have beftowed the leaft care: the talents they have difplayed in their memoirs do not permit us to doubt that they will fully accomplifh their object.

The clafs again propofes the fame fubject. The prize will be doubled, and will confift of two kilogrammes of gold (about 280l. fterling). The memoirs muft be tranfmitted to the fecretary of the Inftitute before the 15th of Meffidor, year 12. The determination of the clafs will be publifhed in the public fitting of Vendemiaire, year 13.

GALVANIC SOCIETY, PARIS.

The fitting of the Galvanic Society at the Oratoire, on the 14th of October, was remarkable both on account of the prefence of the learned men and diftinguifhed philofophers who compofe it, and of the nature of the experiments made on cold-blooded and warm-blooded animals.

C. Aldini conducted thefe experiments with a great deal of method. The principal ones were as follow:

1ft. Several frogs recently fkinned exhibited in fucceffion the phænomenon of a very fenfible contraction without the interpofition of any metallic fubftance, and by the mere contact of the nerves of each with the mufcles.

2d. The animal arc was feveral times obtained, and rendered fenfible by the fame difpofitions as in the preceding experiment.

3d. The phænomenon of fimultaneous mufcular contraction, in three frogs recently prepared, and placed at the fide of each other in the fame direction, was produced at firft by the aid of filver alone. But C. Aldini, being defirous to prove that the fluid which acted on thefe animals was not metallic electricity, changed the pofition of the intermediate frog by placing the fuperior extremity of the trunk of the latter parallel to the inferior extremities of the other two. A contraction being then obferved in the firft and laft without producing any effect on that placed in the middle, C. Aldini concluded, that, as the fluid did not purfue the fhorteft way of communication, it could not be the electric fluid of metals, one of the general laws of which does not allow it to deviate from the fhorteft route.

In another feries of experiments the fame philofopher exhibited the phænomena of the greateft excitability refulting from the application of the Galvanic conductor. 1ft, Towards the medulla oblongata of the head of a warm-blooded animal recently feparated from the trunk. 2d, On the trunk itfelf. 3d, On the head and trunk; at the fame time making the anus on the one hand, and the ear on the other, communicate with the Galvanic battery. A fmall quantity of blood fcattered over the table contributed, no doubt, to the energy of this fimultaneous contraction of the two parts placed at a remarkable diftance from each other. 4th, On a portion of the mufcles detached from the body of the fame animal.

5th. The crural nerve of a frog, brought into contact with one of the mufcles of the warm-blooded animal, exhibited evident figns of contraction.

6th. The heart of the fame warm-blooded animal, placed in a veffel and fubjected to the impreffion of the galvanic battery, gave no figns of excitability. This, indeed, is one of thofe organs which are fooneft decompofed after the death of the individual.

The members of the fociety paid the utmoft attention to all thefe experiments; and the prefident, C. Nauche, congratulated in their name C. Aldini on the manner in which he had conducted them, and the zeal he had fhown to fupport, by new facts, the theory of his illuftrious uncle Galvani.

From thefe facts it feems to refult, 1ft, That the animal fluid fupplies the place in analogous experiments of the electric fluid propagated by metals. 2d, That this animal fluid has no need of any other conductor than the organized parts. 3d, That the nerves and the mufcles are the fureft conductors of this fluid; and, confequently, that experiments tried either on the nervous plexus or the origin of the nerves muft prefent the moft ftriking and decifive effects. 4th, That the different metals, in whatever manner applied, in cafes analogous to thofe in queftion, perform no other functions than that of favouring, more or lefs, the propagation of this univerfal fluid, which penetrates eafily, and in preference to all others, the nervous and mufcular parts of organized bodies.

TOURLET.

ACADEMY OF SCIENCES, TURIN.

The Galvanic Committee of this Academy, confifting of profeffors Giulio, Vaffalli-Eandi, and Roffi, continue their experiments with great fuccefs.

C. Giulio will foon prefent to the academy two reports on this

this ſubject. In the firſt, after recurring to the experiments which he made in 1792, 1793, and 1794, on ſeveral plants, in order to ſhow how far they were ſenſible to the Galvanic influence by the ſimple medium of *arming* and of metallic arcs, he gives an account of new experiments made lately, in conjunction with Vaſſalli-Eandi, on the different ſpecies of ſenſitive plants, ſuch as the *mimoſa pudica*, the *mimoſa ſenſitiva*, the *mimoſa aſperata*, and the *caſſia ſenſitiva*, which prove that the muſcles of their leaves are ſenſible to the influence of the Galvanic agent called forth by the Voltaic pile.

In the ſecond he gives an account of the reſults obtained by experiments made on a man decapitated, September 18th, in one of the halls of the national college. The principal of theſe reſults were as follow:

1ſt. By making one extremity of the pile communicate with the interior of one ear moiſtened with a ſolution of muriate of ammonia, and the other extremity of the pile with the other ear, very ſtrong contractions were produced in the muſcles of the face: but the contractions of the temporal muſcles, the pterygoid, and maſſeter, were particularly ſtriking, for they elevated and agitated the lower jaw with ſo much force, that the gnaſhing of the teeth was diſtinctly heard at the diſtance of ſeveral feet.

2d. By eſtabliſhing a communication between the ſpinal marrow and the large nervi ſympathetici and vagi armed, and between different regions of the breaſt moiſtened with the ſame ſolution, and the other extremity of the pile—before the cavities were opened very ſtrong tetanic ſhocks were obtained throughout the whole body; ſuch violent palpitations of the heart, that the hand applied on the region of the fifth and ſixth ribs was ſtrongly ſtruck by them; inſpirations and expirations, with a hiſſing noiſe which accompanied the entrance and eſcape of the air.

3d. After opening the breaſt the palpitations of the heart ſtill continued, and could be diſtinctly perceived: when they had ceaſed, they were renewed by eſtabliſhing a communication between the heart and the pile, the large nervi ſympathetici and vagi and the pile.

4th. By arming the abdominal aorta and the plexus cœliacus, and then making them communicate with the pile by means of two reſpective arcs, contractions were produced in the abdominal aorta.

Theſe experiments, added to others announced in a report made to the academy on the 15th of Auguſt laſt, leave no doubt

doubt in regard to the irritable mufcular contractility of the arteries, and of the influence which the nerves have in their action.

5th. By arming the anterior nervous branches of the laft dorfal nerves and of the thoracic conduit, and eftablifhing a communication between that conduit and an extremity of the pile, and the armed nerves and the other extremity, evident contractions were produced in the thoracic canal. Phyfiologifts know what difputes have taken place for and againft the irritable contractility of this canal. The experiments of the Galvanic committee of Turin remove all doubts on the fubject: in a decifive manner it prefents, for the firft time, an irrefragable proof of the irritability of the canal of the chyle, and of the exiftence of mufcular fibres in the tiffue of that canal.

6th, One of the eyes was plucked from its orbit, and laid on a plate of glafs armed with a plate of lead, fo that the pofterior part of the ball of the eye, the trunk of the optic nerve, and the nervous branches of the lenticular ganglion, were in contact with the plate of lead: a communication was then formed between the plate of lead and one extremity of the pile and the fclerotica, and between the tranfparent cornea and the other extremity of the fame pile, by means of exciting arcs.

The fpectators were greatly aftonifhed to fee the pupil inftantly contract. An incifion was made in the cornea; and a fine gold wire being brought into immediate contact with the iris and the laft filaments of the ciliary nerves, a movement was obferved in the iris, and a greater contraction in the pupil. There are irritable fibres then in the iris, notwithftanding what many authors have faid to the contrary. But what is the direction of thefe fibres? The profeffors propofe to make this a future object of refearch.

7th. By introducing an arming of lead into the anus, and making it communicate with the pile, while another communication was eftablifhed between the furface of the inteftines and the other extremity of the pile, evident contractions were produced in the mufcular tunic of the inteftines, efpecially when uncovered by the feparation of the exterior membranous tunic, a continuation of the peritoneum.

8th. A long portion of the right anterior mufcle of the leg being extended on a plate of glafs armed with two plates of lead, the two extremities of the mufcle, when touched by the two ends of the arc, without the intervention of the pile, approached each other, and the nerve immediately became fhortened

ſhortened one half. Theſe motions took place even when the arming was removed.

Theſe experiments were made in the preſence of the commiſſary-general of the police, ſeveral profeſſors of the Athenæum, the members of the academy, and a great number of other enlightened citizens.

XVI. *Intelligence and Miſcellaneous Articles.*

VACCINE INOCULATION.

THE following letter, addreſſed by A. van der Velden, ſurgeon and man-midwife at Workendam, to the editor of a Dutch Journal intitled *Algemeene Konſten Letter-Bode* 1802, No. 41, we have tranſlated from that work.

"By the encouragement of ſome friends to humanity, and ſome of our principal medical men, who have exerted themſelves very much to recommend the cow-pock inoculation at this place, about 140 have been inoculated by me and J. Heilijers, ſurgeon and man-midwife at Wondriehem. I am therefore induced to ſend you the following information, with the hopes that it may contribute to the preſervation of thoſe who are ſuffering under the ſmall-pox. In the courſe of the preſent month I was called in by an inhabitant of this place who had the misfortune to loſe two of his children by a confluent ſmall-pox of the moſt malignant ſort, and the third, the only one remaining, was exceedingly ill of the ſame diſorder. Convinced that no injury could ariſe to the patient, I applied the vaccine, being provided with a lancet armed with good matter, and had the happineſs to find, the ſecond day after the vaccination, that the ſymptoms of the ſmall-pox were much mitigated; but on the eighth, and particularly the ninth day after the vaccine inoculation, the puſtules of the natural pox dried up and fell off. In the mean time the vaccine continued to operate, and the following day the child was perceptibly better, and no bad conſequence enſued.

"If you think this ſimple caſe worth inſertion in your Journal, as a further proof of the power and utility of the vaccine, it will give me great pleaſure, eſpecially if it ſhall benefit the public, and excite the attention of others."

ANTIQUITIES.

M. Akerblad, a learned Swede, has opened a new field to the lovers of antiquities, and enlarged the boundaries of our knowledge,

knowledge, by overcoming difficulties fo great, that the firſt critics of Europe have hitherto confidered them as unfurmountable. He has immortalized himfelf by a difcovery which will form an epoch in literature, and has given a folution to one of the moft curious problems in erudition by difcovering the antient alphabet of the Egyptians, and analyfing it in his *Lettre fur l'Infcription Egyptienne de Rofette*, Paris, 8vo. *de l'Imprimerie de la Republique*, year 10.

This interefting pamphlet is fold at Paris by Treuttel and Würtz, bookfellers, Quai Voltaire, as well as the following work of M. Akerblad, who feems to have been born to unveil the myfteries of the Eaft: *Infcriptionis Phenicia Oxonienfis nova Interpretatio*, Parifiis, an. 10, 8vo. This is a new explanation, much happier than the preceding, of a Phenician infcription which had exercifed the ingenuity of the learned Barthelemy and of Simon.

M. Akerblad had before explained, in the Memoirs of the Academy of Göttingen, for 1801, another infcription which he found in the city of Athens. He explained alfo in the *Magazin Encyclopédique*, *Ventofe*, year 10, an infcription in a Coptic manufcript, which it appeared impoffible to decypher, becaufe it was written in the running hand of the Copts, till then unknown. It only remains for us to wifh that M. Akerblad may proceed to London to copy, in the Britifh Mufeum, and publifh with his tranflation, the famous Coptic manufcript of Dr. Afkew intitled *Piftis Sophia*, which would throw great light on the antient philofophy of the eaft.

D'Ansse de Villoison,
of the National Inftitute of France.

The Society of Antiquarians of London have caufed an accurate delineation to be made of the Greek infcription, accompanied by two others in honour of Ptolemy-Epiphanes, and found on a ftone in Egypt, which has fince been brought to London. This delineation of the Greek infcription is of the fame fize as the original, that is to fay, 1 foot 3 inches in height, $2\frac{1}{2}$ feet in breadth, and containing 54 lines.

A copy tranfmitted to the Royal Society of Göttingen was laid before the members in their fitting on the 4th of September by profeffor Heyne, accompanied with a commentary. In the fame fitting was laid before the Society of Göttingen, a paper intitled *Prævia de cuneatis quas vocant Infcriptiones Perfepolitanis legendis et explicandis Relatio*, by G. F. Grotefend, colaborator in the fchool of Göttingen, who,

who, without being an orientaliſt, has accidentally fallen on the means of explaining this obſcure writing merely by his expertneſs in the art of decyphering. The reſult of his reſearch is, that theſe wedge-like figures are actually characters, and not ſyllables, which proceed from right to left; that the language of theſe inſcriptions is Zendic; and that all the Perſepolitan inſcriptions which he has hitherto been able to explain relate to Darius Hyſtaſpes, and Xerxes.

ASTRONOMY.

1ſt. One of the moſt ſingular phænomena in aſtronomy is, to ſee the ſtar Algol decreaſe in light every three days. I obſerved it very ſenſibly on the 29th of September. It was at 11 hours 15 minutes mean time that its light was the leaſt.

2d. The eclipſe of the ſun on the 27th of Auguſt, which I could not ſee at Dijon, was obſerved at Viviers by C. Flaguergues, and at Marſeilles by C. Thulis. The end at Viviers, 18 h. 13 m. 24″; at Marſeilles, 18 h. 11 m. 24″. I thence conclude that the conjunction took place at 19 h. 9 m. 46″ true time at Paris.

3d. C. Pons, keeper of the obſervatory of Marſeilles, has diſcovered a ſecond comet. I ſent him a ſmall preſent. I have requeſted the miniſter to ſend him one more conſiderable, in order to encourage amateurs to ſearch for comets, which are now the great deſideratum in aſtronomy.

4th. I have carefully examined the Egyptian Zodiac which C. Denon has publiſhed. I have obſerved that the ſign Cancer is found in the two lines; it is at the end of the aſcending ſigns and the commencement of the deſcending. This ſeems to indicate clearly that the ſolſtice was in the middle of Cancer. This would go back to 1470 years before the vulgar æra. But I have ſhown in my Aſtronomy, that in the time of Eudoxus, 370 years before the vulgar æra, the Greeks followed this method from ſome antient Egyptian tradition, which they did not correct becauſe they made no obſervations.

5th. The ſmall tables of logarithms juſt publiſhed, being the moſt correct and convenient, the miniſters of the interior and the marine have determined that they ſhall be ſent to all the national ſchools. DELALANDE.

NEW COMET.

In our laſt we announced this diſcovery by C. Mechain on the 28th of Auguſt, at nine in the evening, in the conſtellation of Serpentarius. It was riſing rapidly towards the North pole,

pole, following the right fide of Serpentarius and the oppofite fide of Hercules. It was near enough to be obferved by the naked eye.

On the 2d of September C. Mechain tranfmitted to the Inftitute a report on this comet. The elements he affigned to it were as follow:

Mean time - - - - -	94^h 24′ 6″
Right afcenfion - - -	249° 18
South declination - -	6 11 31.

TANTALITE—A NEW METAL.

A new metallic fubftance has lately been difcovered in Sweden. It was extracted by the celebrated chemift Ekeberg from a mineral given to him by M. Geyer. This mineral, found in Finland, had been claffed among the ores of tin. M. Edelcrantz, of the Academy of Stockholm, tranfmitted a fpecimen of it to Delametherie, who gives the following defcription of it. It has a blackifh colour, with the metallic afpect of cryftals of oxidated tin. Its colour is equally dark; its gravity is confiderable; it ftrongly fcratches glafs. Several facets are diftinguifhed in it, but the cryftal is incomplete. M. Ekeberg has extracted from this mineral a new metallic fubftance, to which he gives the name of *Tantalite.* It forms the twenty-third metallic fubftance.

SILVER AND IRON.

C. Guyton announced, 25 years ago, that iron and filver brought together into perfect fufion formed two feparate buttons adhering by their furfaces. He thought he could thence conclude, contrary to the opinion of Gellert, that thefe two metals cannot be alloyed.

The ingenious experiments of Coulomb on magnetifm having rendered it neceffary for that philofopher to procure metals warranted free from iron, C. Guyton propofed to him to try a button of filver from which it appeared that nature itfelf had feparated the iron.

The filver, indeed, did not contain a quantity of iron which could be rendered fenfible by chemical re-agents, fince a folution of it did not give an atom of blue with pruffiate of foda. A portion of the fame fragment exercifed a fenfible action on the magnetic bar; and Coulomb, having fubjected it to his magnetic apparatus, found that it contained a thirtieth of iron.

It then became of importance to examine whether iron did not contain a certain quantity of filver. This C. Guyton did with his ufual ability. He affured himfelf that in iron there is

is an eightieth, or nearly fo, of filver intimately combined; and that this quantity is fufficient to give it very remarkable properties, fuch as extraordinary hardnefs, and a fracture which prefents, without continuity, rudiments of cryftallization.

C. Guyton concludes from thefe experiments on filver and iron, as well as from thofe which he made on iron and lead, that it can no longer be faid that thefe metals refufe to form an alloy, and that there is actually an union in their fufion; but that by a real quartation the greater part of the two metals feparates while cooling in the ratio of their weight, and exactly as copper and lead feparate in grand metallurgic operations.

RAPID DISORGANIZATION OF THE HUMAN BODY.

On the night of the 16th of March, 1802, in one of the towns of the State of Maffachufetts, the body of an elderly woman evaporated and difappeared from fome internal and unknown caufe, in the duration of about one hour and an half. Part of the family had gone to bed, and the reft were abroad. The old woman remained awake to take care of the houfe. By and by one of the grand-children came home, and difcovered the floor near the hearth to be on fire. An alarm was made, a light brought, and means taken to extinguifh it. While thefe things were doing, fome fingular appearances were obferved on the hearth and the contiguous floor. There was a fort of greafy foot and afhes, with remains of a human body, and an unufual fmell in the room. All the clothes were confumed; and the grandmother was miffing. It was at firft fuppofed fhe had, in attempting to light her pipe of tobacco, fallen into the fire, and been burned to death. But on confidering how fmall the fire was, and that fo total a confumption could fcarcely have happened if there had been ten times as much, there is more reafon to conclude that this is another cafe of that fpontaneous decompofition of the human body, of which there are feveral inftances on record. It is to be regretted the particulars have not been more carefully noted.

XVII. *On Painting.* By Mr. E. Dayes, *Painter.*

Essay VI.

On Composition or Disposition.

——————— but in such order all,
As, though hard wrought, may seem by chance to fall."
Duke of Buckingham.

Composition is the forming of a whole by the union of various dissimilar parts; or, in a more painter-like sense, the art of arranging the figures and other materials of a picture in such a manner that the whole may appear as if the result of chance, though produced by the most consummate art.

Before we proceed to offer such rules as are to be extracted from the works of the most esteemed masters, it may not be improper to premise what previous knowledge is necessary to enable us to produce a composition.

When we have occasion to speak of the works of certain artists, we wish at all times to be understood as referring *through them to nature*, for it must ever be remembered *that art cannot furnish its own rules.*

Some who have written on the arts have recommended particular books for the use of young artists; which is supposing a certain quantity of information sufficient to make a painter. Where he is to begin his inquiry every one knows; where to stop, no one can tell: one thing is certain, there is no danger of too much knowledge making him spoil his work.

It is of the first importance to imagine well our picture. To this end we must take every means to become well acquainted with the history whence our subject is drawn, that we may become familiar with the characters we are to represent: hence a reference to their lives becomes necessary, that we may not mistake a bad man for a good one from the show of one good action. This is not all; time and place must be attended to, that we may not confound the customs of one people with the manners of another. The country, also, should be characterized by its trees, rivers, monuments, and public buildings, as well as the inhabitants by their dress and manners.

All this, nay more, being absolutely necessary, how is it possible that an artist with a little reading can accomplish a work like a historical picture? As well might we suppose the merely

merely reading Homer fufficient to enable us to defign from that author without any previous hiftorical information.

He who firft acquires a knowledge of geography will not only better underftand hiftory and biography, but receive a higher relifh for them than had he followed a different order of reading. What gives us an intereft in Æneas, but our fuppofing him the founder of the mighty empire of Rome? Otherwife, he becomes a mere robber.

As all this knowledge cannot be obtained without much attention, we fhall find great advantage refult from making memorandums under their refpective heads of the cuftoms, manners, buildings, and other circumftances connected with hiftorical painting; by which means we fhall collect a mafs of information at all times ready to refer to, and that without its interfering in the leaft with our practical ftudies. Lord Bacon juftly obferves, "The proceeding upon fomewhat conceived in writing, doth, for the moft part, facilitate difpatch; for though it fhould be wholly rejected, yet that negative is more pregnant of direction than an indefinite, as afhes are more generative than duft."

Thofe who propofe to themfelves to purfue the great and arduous tafk of hiftory-painting, fhould be careful to guard againft commencing their career too foon, or before they have obtained a ftock fufficient to that end: fome have ftarted with fo flender a capital that it has been confined to colour, *chiaro-fcuro*, with, now and then, a fuccefsful compofition; requifites that do not fink below the fuperficies.

The acquirements neceffary to qualify an artift to purfue the great and important part of the art we are treating of, are many: he fhould poffefs a thorough knowledge of the human figure as far as it regards his art, and its attire, with landfcape, architecture, *chiaro-fcuro*, and colour: he fhould be well read in hiftory, antiquity, and the beft poets; to which he fhould join a knowledge of practical geometry, as the foundation of perfpective; with that part of optics called chromatics, as it explains the colours of light and of natural bodies; and, withal, poffefs a tolerable facility of hand. Nothing can be more difficult than to fill up the character of a great artift, particularly if he propofes to raife a juft and lafting reputation; and, not content, like the generality of the profeffion, to produce trifles, extends his views beyond the prefent generation by the cultivation of works that may flourifh in future ages. To do this, as well as the above acquifitions he fhould be endowed by nature with noble and elevated fentiments; a ready and warm genius to invent, accompanied with the greateft coolnefs to arrange; penetration

penetration to apply a juftnefs of character, with patience and induftry to carry him through the detail: in fact, his nature fhould be fo formed as to poffefs the contrarieties of hot and cold; that is, with the greateft vigour fhould be united the greateft caution.

O the godlike attribute of extending benefits beyond the grave! Where are now the antient heroes? Their names are fcarcely remembered, and their mifchiefs have long ceafed to trouble; while the labours of a Homer, a Virgil, a Shake-fpeare, and Milton, with a long lift of worthies, give bread at prefent to thoufands!

Some one has well obferved, "The great end of books is to fet the mind a-going:" all we can hope from our efforts is, to raife in the mind that fpirit of inquiry that may ultimately lead to an imitation of the great, the noble, or beautiful: all the reft is froth.

It was their high notions of the art that led the old mafters to fuch an exalted perfection as to become the admiration of the civilized part of the world, and placed them among the firft order of mortals, or thofe who have extended their fervices beyond their being.

Anger, hatred, and revenge, are paffions poffeffed by every one in common with the brute; but to underftand that infinitely remote point of perfection which conftitutes the foundation of true art, is the reward of few.

It is a misfortune for the art, that every one imagines himfelf a critic in painting; all are tried by their peers but the poor painter: but let thofe who are in affected raptures at the touch of a pencil, or the neatnefs of handling, recollect they are the moft trifling and infignificant parts of the art; criticifm fhould be general in all great works: it is a common precept in art, that an attention to the whole fuperfedes all confideration for the parts *.

In wit, as nature, what affects our hearts
Is not the exactnefs of peculiar parts;
'Tis not a lip or eye we beauty call,
But the joint force and full refult of all.

Pope's Effay on Criticifm.

* It muft not be underftood that the above precept goes to recommend a neglect of the fubordinate parts. Over-finifhing (that is, the nicely defining the form of each part of an object, as a hand, foot, &c.) is not one of the faults of the Britifh fchool. This fault, of want of care in making out the parts, is by fome improperly afcribed to fir Jofhua Reynolds. That great man was not without his defects; but we, as rational beings, fhould avoid them. It would be a poor juftification for the practice of a vice, becaufe we faw it in another. It is much to be doubted, whether the perfections of a great mafter will ever be properly felt by the mere imitator: the reverfe is certain.

Petty criticiſm ſhould be puniſhed with ſilent contempt. We might as well "hew blocks of marble with a razor," or "whiſtle to mile-ſtones," as attempt to convince ſome people. There is an applauſe which is ſuperior to all others, that is, our own, from a conviction of well doing; or, in other words, a conſciouſneſs that our induſtry is rewarded with improvement. He who is too anxiouſly eager for the applauſe of others, exchanges independence for uncertainty, and happineſs for diſappointment. Beſides, he is in danger of falling into a ſtyle familiar and common, ſuch as may beſt ſuit the ideas of ordinary life and vulgar opinion. We muſt be careful not to refine our delicacy to too high a pitch, otherwiſe we ſhall render ourſelves liable to be wounded by every petty criticiſm. Many with whom our ſituation compels us to have an intercourſe are no judges of art; others are influenced by prejudice; many delight to wound: but, whether the obſervation be the reſult of ignorance or vanity, the beſt mode of puniſhment will be neglect.

We have already noticed, under *Invention*, the two characters of compoſition, as the grand and pictureſque; that the former applies to grave and ſerious ſubjects, while the latter appears to aſſociate beſt with gay and ſportive ones. Beauty and grace not only delight in, but derive their greateſt power from, mild variety: hence one of the great beauties in our common writing characters reſults from the ſwell or the oppoſition of force and delicacy in the lines, which give grace independent of form: the ſame thing enriches and adds ſpirit to a maſterly outline, to which if we join fine (we mean true) form, it will poſſeſs the firſt or higheſt kind of excellence. Among the profeſſion there is great difference of opinion relative to compoſition; we ſhould therefore wiſh to be underſtood as offering thoſe rules that relate to matters of taſte with delicacy and modeſty, for fear of forcing genius into one particular track of operation.

Nothing can be more falſe than to ſuppoſe the art of compoſition ſubject to ſome poſitive law, or that the figures of a group ſhould be invariably compoſed under ſome particular form. Men who look to pictures, and from them obtain all their knowledge, are apt to run into this error, and ſuppoſe, becauſe they ſee a group in ſome celebrated picture make ſomewhat of an angle, that all figures to be well put together muſt aſſume the triangle. Others, in contradiction to that doctrine, maintain that the true Venetian method of compoſition requires the group to incline diagonally, that is, running from corner to corner of the picture, aſſerting that the former method is barbarous and French: another ſet of men call

the horizontal line *ſimplicity*, and the true Roman method, expecting to ſee a range of heads of an equal height running through the greateſt part of the work.

He who wiſhes to affect with ſorrow or melancholy can only expect to ſucceed by the removal of whatever may be likely to pleaſe, either from variety and contraſt of forms, brilliancy of colour, or ſtriking effect of light and ſhade; and one great aid will reſult from telling the ſtory with few figures, which greatly adds to ſimplicity.

The great reaſon why Raphael is preferred for compoſition is his poſſeſſing a ſtyle more ſimple and expreſſive than any other. Simplicity appears to have marked the characters of the Roman and Florentine ſchools, as alſo that of the Caracci; after whom we muſt place Pouſſin, Le Sueur, Bourdon, and ſuch others as have affected the ſame ſimple and expreſſive manner.

Le Brun, though an artiſt of great merit, has, in many inſtances, ſo crowded his compoſition with incidents, that the attention is entirely taken from what ought to conſtitute the principal feature, and the mind becomes diſtracted amidſt a multitude of events: witneſs his Crucifixion, and Slaughter of the Innocents. Expreſſion derives much of its force from ſimplicity. Sterne, in his Sentimental Journey, was obliged to take a ſingle captive to give force to his deſcription. What can more ſtrongly affect our feelings than his Maria? A multitude of objects ruſhing on the ſight deſtroy intereſt, and, in ſingle objects, too many parts produce the ſame effect: hence the neceſſity of not over-crowding with ornaments.

It appears pretty certain that the ſhape of the group muſt depend greatly on the nature of the ſubject. A triumph muſt neceſſarily aſſume a different figure to a ſpectacle like a deſcent from the croſs, becauſe it would be ſo in nature.

Diverſity does not carry with it ſo much art, or the appearance of art, as is generally ſuppoſed; for, if we diligently attend to nature, we ſhall find an infinite variety of formed groups reſulting from the diſpoſition of ſome men to ſit, others to ſtand, the contraſt of children with adults, men on horſeback, the irregularities of ground, and a variety of other circumſtances,—all tending to produce a diverſified and irregular maſs, probably aſſuming, more frequently than any other, a general figure approaching to the pyramid.

If we examine the moſt approved compoſitions of the Roman, Venetian, or other ſchools, we ſhall find not only the general diſpoſition tending to the pyramidal figure, but each group taken ſeparately,—with this difference, that in the Venetian and Flemiſh it is rendered more exceſſive. Hence,

G 3 from

from a dash of excess in Rubens he becomes a better master to study than any other, but he must be studied with caution. The close adhesion of his figures points out the method of composition, the striking and conspicuous manner of arrangeing his tints evinces the plan pursued in grouping the colours; while the union of shadow with shadow, and light with light, is seen in the breadth and vastness of his masses. By his excess we may learn, as from Diogenes in morals, who observed he acted like musicians, who gave a higher tone in order to indicate a true one.

The affectation of contrast in some artists is abominable; it looks studiously absurd to see a woman lying on the ground with a child at her breast, and another playing near her; besides the common trick of mixing, in *quantum sufficit*, naked with clothed figures; old men with young ones; side opposed to the full face; the contrast of violent motion with languid attitudes; and a thousand other petty arts to trap the unwary. Such violent opposition will never please the judicious. Where the highest degree of the picturesque is intended, it should never be carried to excess. How ridiculous would it appear in a landscape to see trees crossing each other at right angles, or one vertical and another horizontal! In this instance we may take an example from nature, whose progress from season to season is by gentle and almost imperceptible degrees, and not by violent opposition from heat to cold. By the same rule, violent fore-shortenings should be avoided; a little adds dignity, but, in general, the figures had better be composed than otherwise. We should be careful of mistaking bluster and rant for spirit and greatness. "Be not too tame neither, but let your own discretion be your tutor: suit the action to the word, with this special observance, that you overstep not the modesty of nature."

Weak minds are apt, when they attempt the expressive style, to give their figures the wild and extravagant attitudes of lunatics. That grave dignity observable in the works of the Florentine and Roman schools has entitled them to the first place in composition: the next is justly held by the Caracci, whose pupils, as they lost sight of dignity, substituted bustle and show for simple truth. The style of Guercino is forcible and strong, but less elegant and beautiful than Guido, which is easily perceived in the extremities. Poussin has great simplicity in his compositions, though his figures are sometimes too much scattered. He is remarkable for not suffering any low or vulgar thought to break in on the dignity of his story; an error sometimes committed even by Raphael. There are admirable traits of the true Roman

8 simplicity

fimplicity in the pictures of Le Sueur. They are rare jewels; and Le Brun's floning St. Stephen is highly claffical.

Moft of the writers on compofition in painting feem to imagine it to depend on contraft, and recommend it in the ftrongeft manner; but violent oppofition, as before ftated, not only deftroys fimplicity, but is of all affectations the moft difgufting. If oppofition or contraft were a criterion of excellence, the moft violent would become the moft perfect; and, like a caricature, the more unlike nature the better it would be. Variety or contrapofition is certainly neceffary; but the degree cannot be afcertained by weight or meafure, it muft be learned from the works of efteemed mafters. Common fenfe muft dictate the neceffity of not making all the attitudes alike, and alfo keep us from a contrary excefs.

In a fine compofition we fhall difcover, by an attentive examination, all the parts fo depending on the whole, that the removal of any object would deftroy the general good arrangement.

That variety neceffary to the perfection of a group fhould be difplayed in a fingle figure, efpecially if it be a beautiful one. If the figure is feen in front, its grace will be increafed by fhowing the face in profile, with a flight inclination in the cheft *: one of the legs being ftraight, the other fhould be thrown back; and fo of each limb †: but this variety muft depend on the nature of the fubject, as fuch a contraft would ill become a philofopher, apoftle, or fenator.

A fingle figure may be confidered as a group in itfelf, and fuch a ftudied one would by no means unite with many, any more than one taken from a number would do as a fingle figure.

The contraft obfervable in Raphael is not an affectation of variety, but the refult of confummate judgment, where the erect and inactive figure is introduced to give energy and motion to the active. Contraft in him is the refult of neceffity arifing from deep reflection, not the ftudied and infipid oppofition of an old man, a young woman, a boy and a girl, which we often fee in pictures. He knew well a philofopher or an apoftle would not move like a foldier, a virgin like a matron, or children like adults; which appears to make part of that variety obfervable in his works. He

* See Effay on Grace in the laft number of the Philofophical Magazine, and the plates.

† See the Venus de Medicis, Apollo Belvedere, and others, remarkable for grace.

appears alſo to have preferred the action to its termination; which renders the ſtory more clear, and leaves the ſpectator delighted with a ſuſpended motion, and in expectation of its terminating. A man repreſented in the act of walking, and as having terminated his ſtep, will not have ſo animated an effect as one not having finiſhed it. Much of the beauty of the Apollo Belvedere ariſes from the ſtate of action he is repreſented under. We almoſt imagine he is actually moving when viewed in front.

In a great maſter, every thing is the reſult of reaſon: if a limb, ſuch as a hand or foot, is concealed by drapery, it does not ariſe from idleneſs or ignorance; it is done to give beauty to ſome principal members, by not making too great a diſplay of parts, or to avoid what would otherwiſe produce an ugly form.

The grand or expreſſive ſtyle will ever rank firſt; the other, as in the hands of Lanfranco, Cortona, &c. is only the art of agreeably filling a large picture with figures, or merely pleaſing the eye: it may juſtly be termed *ornamental*, and ranks infinitely below the pure pictureſque. *In all works of art, the philoſopher will inquire whether the head or the hand is moſt employed.* Pouſſin, though admirable in compoſition, often excels in the acceſſary parts. In his Pyrrhus, the figures, and diſtant ground over the river, are more beautiful than the principal part; a prodigality avoided by Raphael; nor is he ſo noble in his beſt thoughts; and his women are often ordinary. We wiſh to be underſtood as always diſtinguiſhing between the grand ſtyle and the pictureſque. In the former, the utmoſt ſimplicity is to be obſerved in the arrangement, and every thing like artifice avoided; while the latter admits of, and derives much of its character from, variety.

In a group the artiſt generally prefers unequal numbers, as 3, 5, 7, or 9, which unite with a better grace and afford a greater variety than any other; but, where equal numbers are uſed, thoſe compoſed of two unequal are beſt, as 6, 10, and 14; but double pairs will ill accord, as 4, 8, 12, &c. The principal part of the ſtory ought undoubtedly to occupy the centre of the picture, and the group, by aſſuming a rotund or ſemicircular form, will aſſiſt the light and ſhade, and enable us to bring the principal figure in light, as well as to procure maſſes by combining the ſhadows of ſeveral objects in one. In this reſpect Raphael has diſplayed ſo much judgment, that it appears from his works evident that he would have proved a great maſter in light and ſhade had he been

permitted

permitted a longer life: however, he did enough to furniſh the hint to the Venetian ſchool.

In whatever way we may diſpoſe our group, the principal figure ought to be rendered conſpicuous, either from ſituation, colour, drapery, light, or from all theſe combined. To talk about "effect of light and ſhade," and thereby attempt to juſtify an impropriety, would be reducing painting to a ſtyle merely ornamental indeed! and make paintings of no uſe beyond ſtopping a hole in the wall.

As in the drama the hero of the piece has a greater part to ſuſtain to diſtinguiſh him, ſo ours muſt, as it were, lord it over all the other objects.

> Nor paint conſpicuous on the foremoſt plain
> Whate'er is falſe, impertinent, and vain;
> But, like the tragic muſe, thy luſtre throw
> Where the chief action claims its warmeſt glow.
>
> MASON'S FRESNOY.

It muſt not be underſtood that the principal figure ſhould be more laboured or finiſhed; that would deſtroy the unity which ought to prevail through the whole. In forming our groups, the greateſt maſs ought to be in the middle, and the little or ſcattered parts placed on the edges to give the whole a lightneſs; while ſome places require to be left blank for the ſake of repoſe—for, though our picture ſhould be filled, it ſhould not be crowded. As we muſt alſo ſeek to obtain profundity proportioned to the greatneſs of the group, we ſhould, to give the whole a pleaſing air from a variety in its form, avoid placing the figures in a file. Rubens, whoſe art in grouping his figures is great, ſometimes runs into exceſs by attaching them too much together, ſo as to make them appear to cling as inſeparable; but, as before obſerved, his vices teach us what is right. The golden mean muſt form the object of our purſuit, we ſhould avoid a monotony of forms as well as too great a contraſt; a number of extremities following each other in the ſame line will generally produce a bad effect. We ſhould alſo avoid ſhowing them in the ſame point of view. Pouſſin's Sacrament of Baptiſm is an excellent example, where many figures are pointing, all differing from each other.

In exhibiting the naked we are bound to ſhow the moſt beautiful parts, which is, generally ſpeaking, all the joints. The neck and ſhoulders in the male often form a fine maſs in a group. But, above all, we ſhould never conceal the extremities, from the power of expreſſion they diſplay, as well as the room they allow for the ſkill and abilities of the artiſt.

In

In the female, the naked is ever pleasing, while an artful concealment will augment the beauty and grace.

> But treat the goddess like a modest fair,
> Nor over-dress, nor leave her wholly bare;
> Let not each beauty ev'ry where be spy'd,
> Where half the skill is decently to hide. POPE.

If our story requires more than one group, the same laws must influence us in the conduct of each,—they should certainly not exceed three. The principal one should prevail over the others; and, by placing it near the centre, or in the second stage of the picture, we shall afford the spectator a better opportunity of seeing it, and also furnish ourselves a better opportunity of surrounding the principal group with the other objects.

As we are bound to support an equilibrium in our composition, we ought not to crowd one part of the picture, or leave another too naked; but this must be done without adding weight to weight in a horizontal or perpendicular form. The same holds of *chiaro-scuro* and colour, where mass must support mass.

The painter, speaking to the eye, should, in the choice of his subject, be careful that it admits images striking and grand: it should burst on the spectator like an unexpected peal of thunder. The horses in the pictures of Rubens add much to the dignity, as do also his fine light and shade. As in an epic poem, there should be but one action admitted in our picture: it should be an entire, and above all, a great one, and require no further aids to its illustration than what is contained in the picture;—it ought to explain the history, not the history the painting. As we are not confined to the mere letter of the story, we may use any means consistent with probability to illustrate our subject; as we once saw in a drawing of a triumph, where the artist, to show the cause was love, decorated a car and the shields with such objects as were symbols of that passion; and, further, to show it was connected with Theseus and the Amazons, in the tablet of an arch represented that hero's battle with those heroines: but enough! an ingenious mind will find a thousand ways of displaying itself.

Two actions or points of time should never be admitted in one picture. M. Angelo, in the Capella Sestini, has represented Adam and Eve eating the fruit, and expelled the garden, in the same piece! Raphael's Peter in prison, and delivery, can hardly be called one.

It must be obvious that the parts of each figure should agree

agree so as to produce a whole: for instance, a thin face should not be united with fat hands. The same unity is necessary between the figure and its attire, which should suit the degree and character of the person as well as be adapted to the age and sex.

We cannot do better than conclude this paper in the words of sir Joshua:—"My advice is this: keep your attention fixed on the higher excellencies. If you compass them and compass nothing more, you are still in the first class. We may regret the innumerable beauties which you may want: you may be imperfect, but still you will be an imperfect person of the highest order." That great man in another place, speaking of "the well-grounded painter, says, "as his pre-eminence depends not upon a trick, he is free from the painful suspicions of a juggler, who lives in perpetual fear lest his trick should be discovered."

XVIII. *Observations on the Zodiac at Dendera. By the Rev.* Samuel Henley, *F. S. A.**

As the report of C. Fourrier concerning this zodiac and its high antiquity has made a deep impression on the minds of many, and the argument thence drawn has been deemed of great weight, in opposition to the Mosaic records and revealed religion, I send you the following observations, with the hope that they may reach those who otherwise might not see them, and have their effect upon a large class of readers, who may have too lightly acceded to Fourrier's conclusion.

Denon, speaking of this zodiac as clearly proving the profound knowledge of the antient Egyptians in astronomy, mentions the ruins which contain it, and are extant but twenty minutes ride from Dendera (antiently Tentyra), known at present under the Arabic name of Berbe. Concerning the etymology of this term, various opinions have been offered; but that by the learned De Sacy is most generally admitted. He conjectured it to have been derived from ΠΙ and ΕΡΦΕΙ, *the temple.*

Notwithstanding this conjecture was assented to by Michaelis, Wahl, and Zoega, it has been opposed by Hartmann, who contends that Berba signifies a *pyramid* or *obelisk.* Though supported in this by Schultens, the interpretation rests in part on a conjecture of Reiske, who for Barabi substituted Barami, which, however, in Arabic is plural; and on

* Printed, with the author's corrections, from the Monthly Magazine.

on the persuasion that in Edrisi the description of Berba was more suitable to *pyramids* than *temples*. M. de Sacy replies, with considerable force, that Schultens would have done more justice to Michaelis, if, instead of indulging conjecture, he had opened some Arabic description of Egypt; for example, Macrizi's, where he would have found instances that the term could not signify *pyramids*. Accordingly, a passage is cited from that author which refers to the very place. "Of the number of Berba is that of Dendera, which is a wonderful edifice. It has 180 windows; each day the sun enters by one of these windows, and on the next by the following, till at length it reaches the last, and then returns in a contrary direction." Vansleb (*Nouvelle Relation en Forme de Journal d'un Voyage fait en Egypte*,) describes Dendera as the site of a wonderful temple of the antient Egyptians—*d'une grandeur et d'une hauteur* DEMESURE'E; and visible at two leagues distance. He also, applying the account of Macrizi, and considering the windows as double, makes them to be as many as there are degrees in the zodiac; so that the sun, rising each day in a different degree, throws his rays through a different window, till, by thus completing his course, he finishes that of the year. For this reason, it is added, the temple is regarded as *wonderful*.

Taking these descriptions with the other compartments on the ceilings, given by Denon, one inference, drawn by M. Fourrier, will be readily admitted, which is, that the state of the heavens they exhibit, corresponds with the date of the building. It remains then to determine, from the zodiac in question, what this date was. Denon, on his second visit, thus describes the temple:—"I went to the ruins, and this time took possession of them in the plenitude of repose. I was first of all delighted to find that my enthusiastic admiration of the great temple was not an illusion produced by the novelty of its appearance, since, after having seen all the other Egyptian monuments, this still appeared the most perfect in its execution, and constructed at *the happiest period of the arts and sciences*; EVERY THING IN IT is *laboured*, is interesting, is important. It would be necessary to draw the whole in its most minute detail, to possess ourselves of all that is worth carrying away."

The date of 15,000 years before the birth of Christ seems but ill to agree with this account, when contrasted with the ordinary remains of human efforts, and the uniform effect of human experience. The monuments of remote ages are more remarkable for their rude bulk than elaborate workmanship; but, if this be of the time assigned, it follows that, in the united

united opinions of Denon and Fourrier, 15,000 years before Chriſt was *the happieſt period of the arts and ſciences.* So much for their joint deciſion!

Taking, however, this calculation independently of the ſtructure itſelf, it is fairly admitted to be accurate, ſo far as it is founded on *equinoctial preceſſions*; but, reſerving diſcuſſions on this head for a work ſhortly to be publiſhed *, it will be ſufficient to obſerve that I had thence fixed the age of this zodiac to the very year and day *before the inſcription aſcertaining them was known*, and which has not, *even yet*, been explained.

The plate given from Denon † repreſents the zodiac in two compartments, as it exiſts on the oppoſite plat-bands of the portico of the temple. The two large figures that embrace the whole, he ſuppoſes, repreſent the year; and the winged emblem before their mouth, eternity, or elſe the paſſage of the ſun to the ſolſtices. The diſk, at the joining of the thighs of the upper figure, he pronounces to be the ſun, whence proceeds a beam of light that falls upon the head of Iſis, which repreſents either the earth or the moon. "The ſun," he continues, "ſituated in the ſign Cancer, may perhaps ſhow the period of the erection of the temple, whilſt the figures joined to the ſigns may mean the fixed ſtars, and thoſe in the boats the revolving bodies, the planets, and the comets." After offering theſe conjectures, this modeſt artiſt, under a conviction of their importance, reſigns to others all further development.

Inſtead of adopting what Denon has conjectured, it will be proper to conſider the zodiac anew. Accordingly, the female form bent over either diviſion, is unqueſtionably the Iſis, which by Horapollo is determined to be *the year*. The winged globe, according to Macrobius, is the ſun commencing his courſe. The veil on the head of the Iſis is that myſterious one which the famous inſcription affirms no mortal had ever withdrawn. On the upper bend or ſhoulder of the lower figure are eight lines or units, denoting that the ſun, at the cardinal points of the year, is in the eighth degree of

* A Diſquiſition on the Date, aſſigned by Fourrier, Commiſſioner of the Sciences and Arts in Egypt, to the antient Zodiac there found: whence the extraordinary Darkneſs recorded by Phlegon, and that by the Hiſtorians of China, in the Reign of Quamvu, are identified with the Darkneſs at our Lord's Crucifixion; the Diſcordance between the Eclipſe noted by Ptolemy, as ſeen at Arbela and Carthage, is accounted for; the further Deſideratum for aſcertaining Longitude, required by the Board at Paris, in their Report on Bürg's Tables, ſupplied; and thence, in Reference to the Prophecy of Balaam, the Birth of Chriſt is fixed.

† See Plate IV.

the

the fign; for fo it is ftated to have been by Manilius at the time of the Julian reform, and fuch was, according to Columella, the adjuftment of the Metonic cycle, compared with the tables of Hipparchus. The four ftars, of eight rays each, are the dog-ftar, which governed the Egyptian year, and, being eight months vifible in the upper hemifphere, had a month affigned to each ray, as the fun has twelve rays to defignate the months of his courfe These four ftars here fignify a quadrennium, when, in the Roman year, an additional, or biffextile day, was added to the 365 days, which conftituted the Egyptian. Beneath are twelve other units, as making, in the biffextile year, the folar to exceed the lunar twelve days inftead of eleven. The little circle, with wings, on the breaft of Ifis, marks a new but fubordinate proceffion of the fun's courfe, after the quadrennium has been completed. The waving lines extending along the figure are the Egyptian hieroglyphic for flowing water; while the line of ftars—each marking, by its fix rays, as many portions of time, and, with the fquare comprifing them, the fquare of that number—feverally indicates four times fix hours, or a day. Thefe, amounting to feventy-nine, exprefs two months or lunations, and twenty days over, which correfpond to the two lunar months added by Numa to the Roman year; and, with the twelve days allowed as above, compenfate for the difference between the ordinary lunar year and the folar biffextile, while eight days, anfwering to the fun's advancement in the fign, complete the given number. From the bend of the leg downward, five days are fo difpofed as to fhow the five fupplementary days above twelve months, of thirty days each, that conftitute the Egyptian year. This is evident from the *hornlefs* beetle annexed, which was, among the Egyptians, an eftablifhed hieroglyphic for a month of thirty days. The three ftars on the band furrounding the legs, with the four on the fhoulder, fymbolizing conjointly feven years, give feventy-feven days as the difference between lunar and folar time, and thus reprefent at once the fixty-feven days which the year, by the reform of Julius, had gone back, with the ten days between the winter folftice and the firft of January, or fix days with which he lengthened the months in one part of the year, and four in the other.

Having recourfe to the Ifis of the upper divifion, it will be found, that, inftead of eight units on the fhoulder, fhe exhibits but feven, whereas the laft of the four ftars beneath them wants two of its rays, and the units which follow are not twelve but eleven. To account for thefe variations, let it be obferved, that, before the Julian reform, the Roman year being

being lunar, a month of twenty-two and twenty-three days alternately, named Mercedonius, was inferted after the 23d of February, to adjuft the lunar reckoning to folar; but, as in the year of the Julian reform, the twenty-three days were included, there would of courfe be one day's advance on the calendar computation, which would leave but feven days by the lunar account for the fun's place in the fign; whence the eleven units below would anfwer to the ordinary differences between the lunar year and the folar; whilft the two rays, deficient in the fourth of the ftars, would point out the commencement of the lunar year at Rome on the 1ft of March, and the folar of Julius on the 1ft of January; or, in other words, would correfpond to the augmentation of the year, computed backward, which Numa had made. The ftars in fquares, as before, defignating days, which, to the bend of the leg, amount to fixty-feven, anfwer to the beginning of the year gone back by the Julian computation, while the feven in addition correfpond to the fun's place in the fign, which, with the five fupplementary days round the legs, make the twelve days in the laft year of lunar intercalation, and, as the four divifions between them fhow, are coincident again with a quadrennium.

Perfectly congruent with the whole is the pyramidal figure, having a globe or fun at its top. It confifts of eleven gradations, which anfwer to the eleven days between the folar and lunar year, and the ninety-nine divifions upon it difcriminate the ninety-nine days from the winter folftice, by which Julius adjufted his reform, to the commencement of the Roman year on the 1ft of April. Between, however, the Roman 1ft of March and the 1ft of April a month was left out, or, in other words, had gone back a fign. This is here expreffed by the recefs of Cancer from the zodiac, and agrees with Virgil's commencement of the year with Taurus:

> Candidus auratis *aperit* quum cornibus annum
> *Taurus*—

the precife time of which is defined by what immediately follows:

> ———et adverfo cedens Canis occidit aftro.

If, now, the fetting of the dog-ftar be placed, according to Petau, on the fourth of the kalends of May, and the fixty-feven days which the Roman year had gone back at the Julian reform, thence reckoned, we come to the 26th of February, or 1ft of Thoth, at the commencement of the æra of Nabonaffar, which was that likewife of the Egyptian year. The changes in the Roman year having varied its form, in refpect to its length, as well as the number of its months, and the days

days in them, it had accordingly receded two lunar months, and eight days over, making in the whole sixty-seven, and so fell on the 27th of April, or day of the dog-star's setting, whence the 28th of March would be the first of Aries; but as, according to Hipparchus, compared with Meton and Manilius, Julius Cæsar's year placed the sun in the eighth day of the sign, these eight days allowed, will fix the beginning of Aries at the vernal equinox, and 21st of March.

The anomalies of the Roman year being settled by the year of Nabonassar, or the Egyptian, it becomes evident, from the pyramidal figure, with the sun on its summit and the cavern beneath, signifying the *vacant interlunar cave* of the moon; that the horns of the Pan, symbolizing the horizontal beams of the dog-star, or completion of the canicular year, are placed on the common boundary of the eighth and third gradation, or day, in the eleven, which indicate the difference between lunar and solar time, or 365 and 354, to distinguish the eight days for the excess beyond the two lunations, and the three other days corresponding to the difference of the Roman lunar year, ending at the 23d of February, and the year of Nabonassar beginning on February 26, which was the first of Thoth by Egyptian reckoning.

The bandages round the head of the Pan express the same, with other notes of distinction; for, whilst the uppermost fold has eight points corresponding to eight days, as before, the second exhibits five units, to denote the five Egyptian supplementary days, which, with the five points between them, indicate ten days, as corresponding with the winter solstice, December 21, whence Julius commenced his reform, and the 1st of January, or his new year's date.

But as, under this reform, the Egyptian year corrected the Roman, so the Roman year, thus corrected, was made by Augustus the standard of the Egyptian; for, as that consisted only of twelve months, of thirty days each, with five days in addition, its commencement receded one day on every quadrennium; consequently, from the year of Nabonassar, and that of the reform of Augustus, by Julian reckoning, sixty-four days twelve hours (the year of Nabonassar, which was the Egyptian, beginning at noon, according to the canon of Ptolemy), will show that the first of Thoth, five interceding days being allowed between the Julian correction, taken as beginning from 707 of Rome, and that of Augustus, established in 725, the bissextile four days twelve hours (or, reckoned from midnight, five days), had varied from the 21st of June, or summer solstitial noon, to the 29th of August, three in the morning, at which time Augustus had fixed it:

 for

for ſixty-four days twelve hours and four days twelve hours making ſixty-nine days, and exceeding the ſixty-ſeven days of Julius by two, Auguſtus intercalated between the year 709 of Rome, when Julius's reform was completed, and his own, ſixteen years after, one day every third year inſtead of every fourth; and ſo, inſtead of four biſſextile days, ſix were inſerted. Between three in the morning, when the dog-ſtar roſe, and twelve at noon, when the ſun was on the meridian, were nine hours to complete the canonical day; theſe are accordingly expreſſed by as many lines on the laſt fold of the bandage winding round the forehead of the Pan.

Having then found, by theſe diſcriminations on the zodiac, the opening of the year, from the riſe of Taurus, at the ſetting of the dog-ſtar, which is exemplified by the ſolar circle in a creſcent on the bull's neck, it will be ſeen that the Thoth thence proceeding is repreſented as a bull in a boat (for the heavenly bodies, which were the Egyptian divinities, were held to perform their revolutions in this manner), and as it has been ſeen from the ſtar deprived of two rays on the ſhoulder of the upper Iſis, as well as from the two months difference between the year of Romulus and Numa's, that the ſun's place had been altered two ſigns, the third boat or month proceeds from Gemini to Cancer: accordingly, the foremoſt figure in it repreſents a prieſt taking auguries from the riſe of the ſtar, whilſt the other is evidently Aquarius, or the overpowering of the Nile, at the apparent new moon of Cancer. But Cancer withdrawing from the zodiac, the overflow falls in with Leo; and here, accordingly, Harpocrates appears as on the day anſwering to biſſextile, which is alſo intimated to belong to that year by the ſix leaves on the head of Aquarius, or the Nile. This being ſuppreſſed in the Egyptian kalendar, makes Cancer and Leo run into each other, or confounds the laſt day of one with the other's firſt. The figure preceding Leo has the ſtar of five rays, which, indicating five months, marks Leo as the fifth ſign, whilſt the ſerpent, riſing from under his feet, exhibits the Nilotic year thence beginning, as does the ſerpent behind the Harpocrates, with his head erected from the fourth fold, a quadrennium. The riſing and ſetting dog-ſtar follow, as thus correſponding in reſpect to fixed and moveable time. From the overflow of the Nile, in the ſign Leo, we are brought on to the commencement of the year in Virgo. This is expreſſed by the torch with two flames, followed by a prieſt taking auguries at the year's beginning, which the bull's head, whoſe horns ſymbolize the apparent new moon, and ſtar of five rays above them, ſufficiently evince. This alſo

 does

does the hawk, or revivifcence of nature, with a dog's head, and the two units above the fame ftar. The two figures with ftars, to intimate the five months between the rifing and fetting Dog, introduce Libra. The pedeftal beneath the fcale, with the fun on it, and a fitting figure, as if watching its fhadow, under the index of the equinoctial balance, together with the fun behind, and the other attendant figures, denote the Thoth, or new year's day, beginning from that fign; whilft the fourteen articulations in the tail of the dog will be found to agree with the fourteenth year of the folar cycle, concurrent with the firft lunar, when the fun entered Scorpio. The hieroglyphics next fucceeding, characterize again the beginning of the year, for fuch are the hawk, crowned with the lotus; the wolf, facred to the fun; and the ceraftes, rifing from an oar. The figures of the rifing and fetting ftar are intelligible as before. We now come to Sagittarius, an hieroglyphic, compofed of a human body, with a bifrontal head of a man and a lion; the Nilotic plant, which indicates the overflow, proceeding from the veil under which both are united. The arrow on the bow is the firft beam of the year, whilft the cheft, fore-legs, and body to the wing, belong to Pegafus, or the horfe of the morning. The hind parts of the wolf complete the reference to the new moon of Thoth, commencing from the dawn. The two divifions on the wing ferve to exprefs the diftinction of the lunar and folar difference, which anfwers to the eleven feathers, whilft the twelve intercalations between the wing and tail of the wolf, on which a raven is feated, agree with the obtrufion of the lunar intercalation on the common form of the folar year. Over the wolf's tail is a ftar of five rays, pointing at the diftance between the moveable and fixed Thoth, whilft the prieft, under the mafk of a hawk, the fymbol of a commencing year, immediately follows, and, with an arrow, or firft beam of the rifing ftar, ftops the further progrefs of the bull, which, to exprefs the *moving* Thoth, has an hind-leg joined to his head. This fymbol, indeed, with the two next that follow, is a certain key to the whole, inafmuch as they diftinctly mark the fixing of the firft of Thoth, the dog holding the bull's leg by a chain of nine links, ending with the ftar of five rays as before, whilft five of thefe ftars, furrounding the Taurine fymbol, decide their eftablifhed import. The one between the horns intimates the original rife at the firft of April in the Roman lunar year, at the apparent new moon, that is, the moon on its fecond day, to which add the intercalary month Mercedonius, and the difference is obtained of the fun's entrance on the fign, April 20, which accords

accords with the Roman commencement of the year on the Palilia. Hence, Aries is again found on the 21ſt of March. In perfect congruity with this is the chain of nine links annexed to the ſtar. For, as the ſidereal revolutions in a year, from meridian to meridian, are 366 days, there will conſequently be a day gained by ſidereal reckoning: hence, as the ſun enters capricorn on the 22d of December, at noon, theſe nine days aſcertain the difference between that time and the noon of the 1ſt of January, and thus account for the difference of ten days by the kalendar of Julius when he reformed the Roman year.

Having then found, in this zodiac, the key to the reforms of the Roman year, we have alſo the clue to that of the Egyptian, introduced by Auguſtus in the year of Rome 725, correſponding to the year of Nabonaſſar 720, and making the difference of biſſextiles ſix Egyptian months, or 180 days; but theſe carried back from the 29th of Auguſt, or fixed Thoth, go to the moveable Thoth on the 26th of February. Thus, then, have we the two Thoths, before and behind Capricorn, and theſe 180 days, from the ſun's entrance into Capricorn, with the four biſſextiles between the reform of Julius and Auguſtus, fall in with the ſummer ſolſtice on the 21ſt of June.

But it will be remembered that one of the dog-ſtars on the ſhoulder of Iſis was defective in two rays, and that Numa augmented by two months the Roman year: if, in retroceſſion from Capricorn, theſe two months be cut off, we are ſtopped at the 21ſt of Auguſt, and thence, eight days allowed for the ſun's advance in the ſign, we are brought again to the 29th. To this month Auguſtus gave his name, and Capricorn was his appropriate ſymbol. Suetonius relates of him, that, on conſulting in his youth Theogenes, the mathematician of Apollonia, when the circumſtances of his birth were made known, Theogenes roſe, ſurpriſed, and adored him. The reaſon of this conduct I ſhall elſewhere explain; but here it will be proper to obſerve, that, on the celebrated gem of this emperor's deification, the ſign Capricorn is placed in a circle, with the dog-ſtar behind, which, as five only of its rays can be ſeen, the others ſuppreſſed, will accord with the difference between the 1ſt of January and April, reckoned one way, and, as Auguſtus was born on the 23d of September, adding the difference between lunar and ſolar time (the Roman year being then lunar), to the 1ſt of January in the other. The abſent three rays being thus accounted for, it will be obvious that the remaining five relate to the diſtance between the 23d of September and the 19th of February,

bruary, to which the four biſſextile days again included between the Julian and Auguſtan reform, came to the 23d, when the Roman lunar year was intercalated; and again, from the 19th day of February, the eight days in the ſign reach that of the 1ſt of Thoth, the year being biſſextile, and the exceſs of ſidereal days, from noon to noon, allowed.

It remains to obſerve, that, in adjuſting the Roman mode of dating to the Egyptian, there is a nominal difference of three years, which will be found to be but nominal upon comparing the canon of Ptolemy. Hence what, in Roman reckoning after the reform of the kalendar, appears to be the 722d year of the city, contraſted with Egyptian time, will fall into the 725th: now, as Auguſtus was in his thirty-firſt year, when he fixed the 1ſt of Thoth, in the 725th year of Rome, and made this his *firſt* year in Egypt, the two years from that of Antony preceding were conſidered as ſuppreſſed. This the annexed table will ſhow:

Year of Rome from the 21ſt of April.	Æra of Auguſtus at Alexandria, from the fixed new moon of Thoth.	Dates of the Roman Empire from Coins.	Firſt of Thoth fixed to the 29th of Auguſt, and, in biſſextile years, to the 30th. The aſteriſks mark the biſſextile.
722		A	The date commencing from Antony and New Rome.
723	*		Battle of Actium on the 5th of Thoth. Alexandria taken in the month Meſori.
724	1		The death of Cleopatra, and beginning of the Cæſars, afterward ſtyled of Auguſtus, in Egypt
* 725	2	B	The years of Auguſtus began to be ſtricken at Alexandria on coins
726	3	Γ	The beginning of the æra of the Auguſti at Rome, from the kalends of January, A. U. 727.

Thus, then, as Auguſtus is ſtated to have been born in the year of Rome 691, when the Roman year is referred to Egyptian reckoning, it will be ſeen that, in Roman computation, his 31ſt year fell into this year of reform. In perfect conſiſtence with this, and all that has been adduced, is an inſcription on the ſouthern portal of the very temple in which this zodiac exiſts, and which, though hitherto *unapplied*, is given by Denon. It is rendered by Mr. Aikin thus:

"On account of the emperor Cæſar, god, the ſon of Jupiter,

piter, the deliverer, when Publius Octavius being governor, Marcus Claudius Posthumus commander in chief, and Tryphon general, the deputies of the metropolis consecrated, in virtue of the law, the Propylæum to Isis, the greatest of the goddesses, and to the associated gods of the temple, in the 31st year of Cæsar." Here the inscription breaks off, but, in the Greek, the two words ΘΩΥΘ ΣΕΒΑΣΤΗΙ follow. For these the French translator unaccountably substitutes— *Le College des Prêtres à l'Imperatrice*, whereas it simply signifies *on the sacred Thoth*.

It will now suffice to add, that the nineteen boats under the zodiac exhibit the nineteen years of the Metonic cycle; and to ask, Where *now* are the 15,000 *years before Christ* of the commissioner Fourrier?

XIX. *Memorandums, Hints, Precepts, and Recipes, for the Use of Artists, Manufacturers, and others; including various short Processes either new or little known**.

[Continued from Vol. xi. p. 149.]

Cements for Derbyshire Spar and other Stones.

I. A CEMENT for this purpose may be made with about seven or eight parts of resin and one of bees wax melted together, with a small quantity of plaister of Paris. If it is wished to make the cement fill up the place of any small chips that may have been lost, the quantity of plaister must be increased a little. When the ingredients are well mixed, and the whole is nearly cold, the mass should be well kneaded together. The pieces of spar that are to be joined must be heated until they will melt the cement, and then pressed together, some of the cement being previously interposed.

II. Melted sulphur applied to fragments of stones, previously heated (by placing them before a fire) to at least the melting point of sulphur—and then joined with the sulphur between, makes a pretty firm and durable joining.

Little deficiencies in the stone, as chips out of corners, &c. may also be filled up with melted sulphur in which some of the powder of the stone has been mixed.—Heat the stone first.

* Communications of practical approved recipes and useful hints are requested from our correspondents. We take this opportunity of thanking Messrs. Gill, Pepys, and other friends, for their favours in this way.

Temporary Cements, &c.

Workmen are often at a loſs for ſuch a cement as will hold firmly till they have no further occaſion for it, and yet be eaſily parted when it is neceſſary; as in fixing glaſs plates to blocks to be ground for optical purpoſes, joining metallic plates to be turned in a lathe, &c. For ſuch purpoſes a cement compoſed of the following ingredients will be found to anſwer well:

III. To four ounces of reſin and 1-4th of an ounce of bees wax melted together, add four ounces of whitening (waſhed carbonate of lime or chalk) made previouſly red hot. The whitening ſhould be put in while yet hot, that it may not have time to imbibe moiſture from the atmoſphere. This makes a good cement for holding optical glaſſes on the end of a maundril while grinding, or for ſimilar purpoſes.

To cement plates of metal to the chucks of a lathe in order to turn them, the chuck ſhould be heated, which is commonly done, by directing the flame of a candle upon it urged by a blow-pipe; the metal ſhould alſo be heated in the ſame manner until they will melt the cement applied to them. The pieces, being then placed in contact, are adjuſted centrally while the cement cools, either by holding a pointed ſtick in a ſmall hole previouſly made in the centre of the plate by a prick punch, or by preſſing a piece of wood laterally againſt it. When cold it will be held firm enough, by means of the cement, to bear being turned, and may be diſengaged at any time by again heating it.

IV. Pitch, reſin, and a very ſmall quantity of tallow, melted together, and thickened by ſtirring in dry brick-duſt, is employed by chaſers of gold and ſilver articles to ſupport and hold their work.

This mixture forms a cheap cement uſeful for many purpoſes, as fixing ſmall ſteel articles on the blocks deſtined to hold them for poliſhing, and is much uſed at Birmingham. The proportions of the ingredients depend on the heat of the weather and the particular purpoſe in view. In winter, a larger portion of tallow is neceſſary than in ſummer.

V. Shell-lac is a very ſtrong cement for holding metals, glaſs, or precious ſtones, while cutting, turning, or grinding them. The metal, &c. ſhould be warmed to melt it.

For faſtening ruby cylinders in watches and ſimilar delicate purpoſes, ſhell-lac is alſo very excellent.

Memorandum.—Bees wax mixed with a little colcothar (red oxide of iron) makes a good poliſhing tool for lenses: uſe

ufe a little finely-wafhed colcothar mixed with water for the cutting material, applied between the tool and the lens.

VI. *White of Eggs*

mixed up with a little quicklime (or a bit of chalk burnt in a common fire and pounded) makes a pretty good cement for glafs and porcelain. It is not abfolutely neceffary that the chalk be burnt, though it is generally ufed fo.

Gum Arabic Cements.

VII. Gum arabic diffolved in as fmall a quantity of water as may be, and diluted to a proper confiftence with gin or any proof fpirit, forms a very ufeful cement for all purpofes where gum water is commonly ufed, the fpirit preferving it from becoming putrefcent. As the fpirit evaporates, more fhould be added. It fhould be ftirred and mixed together at the time of ufing. 2. If plaifter of Paris be added to gum water, it makes a cement ufeful to ladies in filligree works.

VIII. Gum ammoniac added to the folution of gum arabic in proof fpirits very much improves the cement. It anfwers very well for joining broken glafs and porcelain articles of ornament.

IX. *A fine tranfparent Glue.*

Shreds or parings of vellum or parchment, boiled for a fufficient length of time in foft water, diffolve at laft into a very tranfparent glue. White leather, that is, fkins dreffed with alum inftead of being tanned, will anfwer the fame end.

Ifinglafs Cements.

X. A ufeful cement is made of this fubftance by either diffolving it in any proof fpirit by heat, or by adding to it, when diffolved in water, an equal quantity of alcohol.

XI. An improved cement may be made by adding to the ifinglafs, previous to its folution in proof fpirits, one third part of its weight of gum ammoniac. Expofe the mixture to a boiling heat until the ifinglafs and gum are diffolved, and until a drop of the compofition becomes ftiff inftantly as it cools. It will at any future time melt with a degree of heat little exceeding that of the human body, and, in confequence of fo foon becoming ftiff on cooling, forms a very valuable cement for many purpofes, particularly for the very nice and delicate one of fixing on the antennæ, legs, &c. of infects in cabinets of natural hiftory.

The eafy melting of this cement is no objection to its ufe in cafes where the articles themfelves may afterwards be expofed to moderate heat; for it owes this property only to the

presence of the alcohol, which evaporates very soon after it has been applied.

When used to join broken glass or china, the pieces to be joined should be previously warmed. Immersion in hot water will give them a sufficient degree of heat. Wipe off the water before applying the cement, which may be laid on with a pencil: then press the pieces together, binding them with a string or a bit of soft wire if necessary.

XII. *Japanese Cement, or Rice Glue.*

This elegant cement is made by mixing rice flour intimately with cold water, and then gently boiling it. It is beautifully white, and dries almost transparent. Papers pasted together by means of this cement will sooner separate in their own substance than at the joining, which makes it extremely useful in the preparation of curious paper articles, as tea-trays, ladies' dressing boxes, and other articles which require layers of paper to be cemented together. It is in every respect preferable to common paste made with wheat flour for almost every purpose to which that article is usually applied. It answers well, in particular, for pasting into books the copies of writings taken off by copying machines on unsized silver paper.

With this composition, made with a comparatively small quantity of water, that it may have a consistence similar to plastic clay, models, busts, statues, basso-relievos, and the like, may be formed. When dry, the articles made of it are susceptible of a high polish: they are also very durable.

The Japanese make quadrille-fish of this substance, which so nearly resemble those made of mother-of-pearl, that the officers of our East Indiamen are often imposed upon.

XIII. *Glue of the Laplanders.*

The bows of the Laplanders are composed of two pieces of wood glued together; one of them of birch, which is flexible, and the other of fir of the marshes, which is stiff, in order that the bow when bent may not break, and that when unbent it may not bend. When these two pieces of wood are bent, all the points of contact endeavour to disunite themselves, and to prevent this the Laplanders employ the following cement:—They take the skins of the largest perches*, and, having dried them, moisten them in cold water until they are so soft that they may be freed from the scales, which they throw away. They then put four or five of these skins in a rein-deer's bladder, or they wrap them up in the soft

* It is probable eel-skins would answer the same purpose.—EDIT.

bark

bark of the birch-tree in such a manner that water cannot touch them, and place them thus covered into a pot of boiling water, with a stone above them to keep them at the bottom. When they have boiled about an hour they take them from the bladder or bark, and they are then found to be soft and viscous. In this state they employ them for glueing together the two pieces of their bows, which they strongly compress and tie up until the glue is well dried. These pieces never afterwards separate.—*Transactions of the Academy of Sciences at Stockholm.*

XIV. *Jewellers Cement.*

In setting precious stones, pieces are sometimes broken off by accident. In such cases they often join the pieces so correctly, that an inexperienced eye cannot discover the stone to have been broken. They employ for this purpose a small piece of gum-mastic applied between the fragments, which are previously heated sufficiently to enable them to melt the interposed gum. They are then pressed together to force out the redundant quantity of gum.

In the same manner cameo heads, but without any ground, made of paste (white enamel or coloured glass) are often cemented on a piece of real stone to serve them for a ground, producing the appearance of a real onyx, from which they can with difficulty be sometimes distinguished.

Backs are also cemented to stones in the same manner, to change their hue. That is, behind a transparent stone the colour of which is wished to be altered, a thin plate of a stone of a different colour is cemented, which alters the colour of the refracted light to a mixed tint partaking of that of both. In this case, the surfaces to be joined are previously ground as flat and true as possible. They are called *doublets.*

XV. *Turkey Cement for joining Metals, Glass, &c.*

The jewellers in Turkey, who are mostly Armenians, have a curious method of ornamenting watch-cases, and similar things, with diamonds and other stones, by simply glueing them on. The stone is set in silver or gold, and the lower part of the metal made flat, or to correspond with the part to which it is to be fixed; it is then warmed gently, and the glue applied, which is so very strong that the parts never separate. This glue, which may be applied to many purposes, as it will strongly join bits of glass or polished steel, is thus made:

Dissolve five or six bits of mastic, as large as peas, in as much spirit of wine as will suffice to render it liquid; in another

other veſſel diſſolve as much iſinglaſs (which has been previouſly ſoaken in water till it is ſwollen and ſoft) in French brandy or in rum, as will make two ounces, by meaſure, of ſtrong glue, and add two ſmall bits of gum-galbanum or ammoniacum, which muſt be rubbed or ground till they are diſſolved: then mix the whole with a ſufficient heat; keep it in a phial ſtopt, and when it is to be uſed ſet it in hot water.—*Eton's Survey of the Turkiſh Empire.*

XVI. The proceſs above deſcribed may be ſimplified by adding the gum-ammoniac to the iſinglaſs during its ſolution in proof ſpirit, and expoſing the mixture to a boiling heat until it is diſſolved, when the ſolution of maſtic in alcohol may be added. The gum-ammoniac previouſly diſſolved with the iſinglaſs promotes the union of the maſtic with the mucilage. This cement has been tried in London, and found to anſwer well: it ſtands againſt moiſture.

Cements which reſiſt Moiſture.

Generally ſpeaking, all cements into the compoſition of which gum-lac or maſtic enters, of which we have already given ſome, poſſeſs this property.

XVII. A cement of this kind may be made by diſſolving iſinglaſs in proof ſpirit, to which muſt afterwards be added a ſolution of ſhell-lac in alcohol.

XVIII. Another cement, which will alſo reſiſt moiſture, may be formed by melting by heat, without water, common glue with half its weight of reſin, to which muſt be added ſome red ochre to give it body; it is particularly uſeful for cementing hones to their frames.

XIX. Carpenters employ a cement in framing ſign-boards, &c. to ſtand the weather, which they make by adding to a pint of well made common glue (made with water) an eighth part of that quantity of boiled linſeed oil, dropping it into the glue gently, and ſtirring it all the time.

XX. White lead ground up with boiled linſeed oil to the conſiſtence of paint, makes a good cement for joining broken porcelain, earthen ware, and glaſs articles deſtined to hold water, &c. After the cement is applied, between the pieces they ſhould be preſſed home to each other as cloſe as poſſible. The cloſer the better; nor need any fears be entertained that enough of cement will not be left in the joint; for the thinneſt film that can be interpoſed will hold firmer than a thicker one would. The articles ſhould remain undiſturbed for two or three months, and before uſing them the cement ſticking on the outſide of the joint ſhould be carefully ſcraped off with a knife.

XXI. *A Cement that hardens under Water.*

Mr. Gad, in the 32d volume of the Memoirs of the Academy of Stockholm, ſtates, that if clay and calces (oxide) of iron be plentifully mixed with oil, they will form a maſs which will harden even under water.

XXII. *A Glue inſoluble in Water.*

Leather-dreſſers or glovers glue, that of fiſh, and that prepared with linſeed oil, ceruſe, and red lead, which cements pretty ſtrongly glaſs, ſtone, and wood, ſtill leave room to wiſh for one of a ſtronger quality.

An excellent glue may be procured from cheeſe. Take ſkim-milk cheeſe, free it from the rind, cut it in ſlices, and boil it in warm water, ſtirring it with a ſpoon until it be reduced to a ſtrong glue which does not incorporate with water. Then throw away the warm water, pour cold water over the glue, and knead it afterwards in warm water, ſubjecting it to the ſame proceſs ſeveral times. Put the warm glue on a grinding ſtone, and knead it with quicklime until you have a good glue. When you wiſh to uſe this glue you muſt warm it: if it be employed cold it is not ſo ſtrong, but it may alſo be uſed in that manner. This glue is inſoluble in water as ſoon as it is dry, and it becomes ſo in forty-eight hours after it has been applied. It may be uſed for glueing wood, and for cementing marble and broken ſtone, and earthen ware. The joining can ſcarcely be diſcovered.

Baits alſo for catching fiſh may be made of it. Fiſh are very fond of it, and it reſiſts water. Boerhaave obſerved that no menſtruum diſſolved cheeſe, not even aqua-regia.—*Tranſactions of the Academy of Sciences at Stockholm.*

XXIII. *A Cement that will ſtand againſt boiling Water, and even bear a conſiderable Preſſure of Steam.*

In joining the flanches of iron cylinders and other parts of hydraulic and ſteam-engines, great inconvenience is often experienced from the want of a durable cement.

Boiled linſeed oil, litharge, red and white lead, mixed together to a proper conſiſtence, and applied on each ſide of a piece of flannel, previouſly ſhaped to fit the joint, and then interpoſed between the pieces before they are brought home (as the workmen term it) to their place by the ſcrews or other faſtenings employed, make a cloſe and durable joint.

The quantities of the ingredients may be varied without inconvenience, only taking care not to make the maſs too thin with the oil. It is difficult in many caſes inſtantly to make

make a good fitting of large pieces of iron work, which renders it neceffary fometimes to join and feparate the pieces repeatedly before a proper adjuftment is obtained. When this is expected, the white lead ought to predominate in the mixture, as it dries much flower than the red. A workman, knowing this fact, can be at little lofs in exercifing his own difcretion in regulating the quantities. It is fafeft to err on the fide of the white lead, as the durability of the cement is no way injured thereby, only a longer time is required for it to dry and harden.

When the fittings will not admit eafily of fo thick a fubftance as flannel being interpofed, linen may be fubftituted, or even paper or thin pafteboard; the only reafon for employing any thing of the kind being the convenience of handling.

This cement anfwers well alfo for joining broken ftones however large. Cifterns built of fquare ftones, put together with this cement, will never leak or want any repairs. In this cafe the ftones need not be entirely bedded in it, an inch or even lefs of the edges that are to lie next the water need only be fo treated: the reft of the joint may be filled with good lime.

XXIV. *Another Cement that will ftand the Action of boiling Water and Steam.*

This cement, which is preferable even to the former for fteam-engines, is prepared as follows:

Take 2 ounces of fal-ammoniac, 1 ounce of flowers of fulphur, and 16 ounces of caft-iron filings or borings. Mix all well together by rubbing them in a mortar, and keep the powder dry.

When the cement is wanted for ufe, take one part of the above powder and twenty parts of clean iron borings or filings, and blend them intimately by grinding them in a mortar. Wet the compound with water, and, when brought to a convenient confiftence, apply it to the joints with a wooden or blunt iron fpatula.

By a play of affinities, which thofe who are at all acquainted with chemiftry will be at no lofs to comprehend, a degree of action and reaction takes place among the ingredients, and between them and the iron furfaces, which at laft caufes the whole to unite as one mafs. In fact, after a time, the mixture and the furfaces of the flanches become a fpecies of pyrites (holding a very large proportion of iron), all the parts of which cohere ftrongly together.

XXV. *An-*

XXV. *Another Cement of the ſame Kind.*

Take two parts flowers of ſulphur and one part ſal-ammoniac, and mix them together with a little water into a ſtiff paſte.

Take alſo borings or turnings of caſt iron in the ſtate in which they are commonly found in works where boring and turning are carried on, viz. mixed with ſand, and ſift them finely to get rid of the groſſer particles.

When the cement is wanted for uſe, diſſolve a portion of the above paſte in urine, or in water rendered ſlightly acidulous, and to the ſolution add a quantity of the ſifted borings. This mixture, ſpread upon or between flanches of iron pipes, or put into the interſtices of other parts of iron work, will in a little time become as hard as a ſtone.

XXVI. *Blood Cement.*

A cement often uſed by copperſmiths to lay over the rivets and edges of the ſheets of copper in large boilers, to ſerve as an additional ſecurity to the joinings, and to ſecure cocks, &c. from leaking, is made by mixing pounded quick-lime with ox's blood. It muſt be applied freſh made, as it ſoon gets ſo hard as to be unfit for uſe.

We believe, if the properties of this cement were duly inveſtigated, it would be found uſeful for many purpoſes to which it has never been yet applied. It is extremely cheap, and very durable.

[To be continued occaſionally.]

XX. *On a new Method of making Cement for Terraces; and the Uſe of liquid Pitch to render them impermeable to Water, and ſecure from the Attacks of Froſt. By* CASIMIR PUYMAURIN.

I SHALL not ſpeak of the nature of the different lime-cements hitherto known, as they have been fully deſcribed by various authors; I ſhall only obſerve, that a cement ought to be hard, ſolid, and impermeable. To obtain a hard and ſolid cement it has been neceſſary to employ different bodies which, by their aggregation with lime, diſſolved in water, ſpeedily abſorb the ſuperabundant moiſture, and furniſh to the particles of lime diffuſed throughout the cement the carbonic acid neceſſary for rendering it ſolid, and regenerating it into calcareous earth.

Vitrified

Vitrified lava, natural and artificial puzzolana, the ſcoriæ of furnaces, pounded bricks, bone-aſhes, have been the baſes of all the cements hitherto made, and they have been obtained more or leſs ſolid. Cements compoſed in this manner have been attended with perfect ſucceſs in the ſouthern parts of Europe, little expoſed to rain: they do not abſorb the exterior moiſture, and the froſt has not power to dilate their pores or to deſtroy their aggregation.

The cements of Italy, Africa, Spain, and other warm countries, unite all thoſe qualities which can be deſired by the moſt exact obſerver; but in our rainy countries, expoſed to very ſtrong froſts, cements ought to poſſeſs a more eſſential quality than hardneſs or ſolidity, that is to ſay, impermeability. Cements compoſed of porous bodies cannot poſſeſs this quality: being hard, and having their greateſt ſolidity during ſummer, the rains of autumn gradually penetrate to their interior parts, to reduce to powder that maſs which a little before had the appearance of the greateſt hardneſs.

The inventors of the moſt celebrated cements have ſeen their experiments fail becauſe they neglected this eſſential quality. The interpoſition of a fat body was long ago employed. Pliny and Vitruvius recommend the thick part of oil, and oil itſelf; but theſe bodies employed alone can never anſwer the intended purpoſe. Oil with the lime of cement forms a ſaponaceous body ſoluble in water: the thick part of oil contains a very large quantity of mucilage, which water diſſolves or carries off.

To preſerve the bottoms of veſſels, and to render them impermeable to water, reſinous bodies have been employed, and particularly liquid pitch. I have thought that my cement ſhould be covered with boiling pitch, as this reſinous body penetrates its pores and renders it impermeable to water. One inconvenience, however, appeared in the uſe of pitch, which is, its property of becoming ſoft during the heat of ſummer. This inconvenience I remedied by beſprinkling the pitch with powder of lime: the lime combines with the pitch, and forms on the cement an exterior ſtratum of new cement reſembling the famous cement of the Romans called *maltha*.

All the merit of my labour conſiſts merely in having firſt employed, for preſerving cements and rendering them impermeable, a fat body capable of penetrating them, of filling up their pores, and of being inſoluble in water.

I ſhall here give the method which I employ for making my cement; but I muſt firſt obſerve, that there cannot be one general method of compoſing cements, unleſs lime-ſtone and

and fand were every where of the fame quality. The obferver, therefore, muft examine the nature of the compofition of the lime he employs, and particularly the purity of the fand and filiceous matters: he may then vary the dofes of the materials of his cement as may be neceffary.

Every method of making cement requires, in general, that the puzzolana, pounded brick, and fcoriæ, be reduced to fine powder and fifted. This precaution is neceffary for cement which is not to be covered with a refinous body: its furface thereby becomes fmoother and more compact, and it is lefs liable to be penetrated by moifture. But this advantage is more than compenfated by the fiffures and cracks occafioned by the fhrinking of the cement. This fhrinking does not take place in cement made according to my method, becaufe I employ all the matters hard, coarfely pounded, and in fragments of the fize of a grain of wheat, and often as large as peas. Thefe fragments broken in this manner prefent a great number of angles and cavities into which the calcareous part penetrates, and thus forms a kind of connected chain, which prevents thofe cracks and fiffures fo prejudicial to cement. The lime which I employed was made from hard and white limeftone of the hill of Cazeres, in the department of the Upper Garonne: this lime diffolves with a fort of ebullition and a great heat, and after its folution forms a white pafte without any mixture of gravelly parts: it is fufceptible of fwallowing, as the mafons here term it, a great deal of fand and other hard matters, but it has lefs ftrength in the open air than meagre lime, which being made from marly ftone contains in its compofition a great many baked and vitrified argillaceous matters, which give it great ftrength when expofed to the open air and to water. This lime, called in the country *chaux de Bourret*, requires little fand, becaufe the calcined and vitrified earthy parts which it contains form with it already an intimate mixture, or a kind of cement: this lime, therefore, diffolved in water, acquires in a little time the hardnefs of ftone.

The lime I employed then was perfectly pure, without any internal mixture of heterogeneous parts, but which has no great folidity when expofed to the open air.

I found that a fifth part of lime was fufficient to give to cement that connecting quality neceffary to envelop all the vitrified and filiceous parts of a calcareous ftratum, and, confequently, to give it the greateft folidity. Such is the procefs I employed to form on a roof, conftructed for two hundred years, the joifts of which were at a great diftance from each other, a terrace of forty fquare fathoms, which ftill exifts,

 and

and has withſtood four ſevere winters and our ſcorching ſummers.

One precaution which I did not take, and which embarraſſed me a good deal, was to pound the limeſtone before it was employed. The ſtone diſſolves in water; but ſome ſtones being leſs calcined than others, their nucleus does not diſſolve, and only becomes penetrated with moiſture. When theſe are blended with the gravel and ſiliceous matters employed, at the end of ſome days the cement bliſters and ſplits into ſmall fragments, and bits of the lime which have not been diſſolved are found in the ſtate of lime ſlaked in the open air.

Take two meaſures of river pebbles well waſhed, or fragments of brick of the ſize of a nut; two of tiles and iron ſcales coarſely pounded, one of river ſand perfectly well waſhed, and a meaſure of the lime of Cazeres, juſt from the kiln, and pounded.

Form a circle with the ſand, and throw into the hollow the lime which has been ſlaked, taking care to mix it thoroughly: when the lime is well diluted leave it in that ſtate for three hours in order that the whole lime may be diſſolved; then mix with it gradually the river pebbles, the iron ſcales, the tiles, and the ſand. This mortar muſt then be worked for half an hour, that every ſiliceous ſtone and fragment of tile may be well incorporated *.

Such is the manner in which I prepare cement. There are two methods of employing it; either above a pavement of brick, or below it. The former appears to be the moſt ſolid during the firſt year, while the other ſuffers the rain water to filter through it, but at the end of a certain time it acquires the moſt perfect ſolidity.

As time deſtroys the timber on which the mortar is placed, when a terrace is intended to be made on a floor it muſt be coarſely covered with ſand and clay: when this covering is dry, another, compoſed of mortar and pretty fat ſand, muſt be placed over it: there is no neceſſity for cutting the bricks, and the upper ſurface muſt be rough or notched with a chiſel. This pavement muſt have an inclination ſufficient to make the water run off.

In the month of July, when the two coverings are very dry, the cement compoſed in the above manner muſt be applied in bands of two feet in breadth; two workmen are ſufficient. This ſtratum of cement ought to be from two

* When the cement is almoſt finiſhed throw over it about a buſhel of quicklime in powder. The mortar then becomes very difficult to be ſtirred. Or two pints of milk of lime are then to be added, which will penetrate the cement in every part.

inches

inches and a half to three in thicknefs; the covering on which it is placed ought to be moiftened with milk of quick-lime; and the cement muft be preffed down clofely with the trowel, taking care to beat it with the fharp edge of that inftrument. It is fmoothed by the back of the trowel flightly moiftened. The furface of the cement muft be again preffed down, to bury the coarfer parts and render the whole fmooth. When the firft band is finifhed the workman proceeds to a fecond, and the two bands muft be carefully united to prevent their feparation.

This cement foon dries, and at the end of an hour can fuftain a ftrong preffure. It muft, however, be left feven or eight days; after which the furface of it is to be flightly moiftened, and then preffed down and fmoothed by means of flat ftones in the fame manner as marble is polifhed. This laft precaution is effentially neceffary, and the folidity of the cement will depend on the care with which it has been performed. When the terrace has been conftructed in this manner, the aggregation of the cement becomes ftronger, and its pores are fmaller and lefs numerous.

In order that the cement may fucceed perfectly, it muft be made during the great heats of July, that the fuperabundant water may evaporate, and that it may be perfectly dry before the autumnal rains. At the end of Auguft, boil pitch, fuch as that ufed for fhips, and fpread it over the cement by means of large brufhes. As this coating would render the cement not fit to be touched during fummer, this inconvenience may be remedied in the following manner:—Take lime, flaked in the open air and reduced to fine powder, and, having fprinkled it over the pitch, remove, by means of a broom, the fuperfluous part of the lime which does not adhere to it. This lime, by combining with the pitch, will form with it a very thin ftratum of cement fimilar to the maltha of the Romans. At the beginning of October a fecond ftratum of pitch and lime muft be laid on.

The fecond method of employing the cement is to place it immediately over the ftratum of brick and clay, and then to cover it with a pavement of brick, mortar, and fand. I have two terraces, fifteen fathoms in length and one and a half in breadth, which appear to me to have the greateft folidity. They are not fo beautiful as thofe where the cement covers the brick; but they can ftand every kind of friction or preffure.

After making a ftratum of clay and fand, fpread over it a ftratum of cement four inches in thicknefs, well beaten, and

 add

add pebbles fomewhat larger than thofe employed in the preceding cement, and increafe the dofe of lime in proportion: the cement muft then be beaten with clubs like thofe ufed for fmoothing the walks in the neighbourhood of Paris. It is then to be left to dry for a month, after which the furface of it muft be moiftened with milk of lime; and the bricks are to be placed with good lime and fand.

It is not neceffary that thefe bricks fhould be ground. I have obferved that, by cutting, their ftrength is leffened, as it deftroys their upper half-vitrified furface: nothing then remains below but an earthy furface, which is foon penetrated by moifture, and which is eafily deftroyed by froft. Care muft be taken to fill up the joints with good mortar, which muft be preffed in and fmoothed by the trowel, and then pitched.

Terraces conftructed in this manner fuffer the water for fome time to filter through them in fmall quantity. This water charged with calcareous particles ftops up the pores of the cement; no more filtration takes place: and terraces of this kind have the greateft folidity, and are exceedingly cheap. This cement may be employed with advantage for the interior of apartments; it alfo may fupply the place of pavements of cut bricks, and cofts two-thirds lefs.

It muft be fpread over a pavement of rough bricks, or bricks picked with an inftrument, to the thicknefs of an inch or nine lines. The pebbles may be omitted, and their place fupplied by fragments of tiles and iron fcales coarfely pounded: it is then to be preffed down and fmoothed with flat ftones, but before it is painted it muft be fuffered to dry for a month. It is painted and waxed in the fame manner as brick pavement.

Such are the details of the cement I have employed, and which has been attended with complete fuccefs. But I fhall here repeat, that the dofes muft be varied according to the greater or lefs purity of the lime and of the other matters employed; and the application of pitch is merely to prevent the infiltration of water, and the deftruction of the cement by froft.

XXI. *A ſhort View of the Craniognomic Syſtem of Dr.* Gall, *of Vienna. By* L. Bojanus, *M. D. Member of the Medical Societies of Jena and Paris, and of the Society of the Obſervers of Man.*

[Continued from p. 84.]

13. *Organ of the Inſtinct of exalting oneſelf.*

THE organ in the middle of the interior edge of the parietals at the upper middle part, and a little towards the poſterior of the head, gives us a true idea of the difficulties which oppoſe the reſearches of Dr. Gall, and at the ſame time furniſhes us with a ſtriking example of the happy opinions of this great obſerver.

He found this organ well expanded in the chamois goat, and ſtill more in the bouquetin; he obſerved the ſame thing in ſeveral men diſtinguiſhed for their pride. It was difficult to collect all theſe obſervations into one point of view. But when he conſidered that the chamois goat inhabits the moſt elevated peaks of the mountains; that the bouquetin always endeavours to aſcend higher; and that pride, when attentively examined, is only a deſire of being ſuperior to others; he was perſuaded that it muſt be this organ which produces theſe effects *different in appearance,* and he conſidered it as the organ of the inſtinct of exalting oneſelf.

The head of the proud man, carried upwards and backwards, tends ſtill more to confirm this opinion.

[It appears to us that the picture of the proud man, contraſted with that of the humble and modeſt, renders the truth of this idea ſtill more ſtriking. In the former, every thing is directed upwards: the hair is highly frizzled; the head is elevated; the eye-brows are arched upwards; the eye-lids are raiſed; the ſhoulders are ſtraight; he walks on tip-toe, and looks on every thing around as beneath him. In the latter the hair hangs down naturally; the eye-brows, eye-lids, and head, are lowered, the body and knees are ſlightly bent: in a word, every thing denotes ſubmiſſion, and that he has no wiſh of being above others.]

14. *Organ of the Love of Glory.*

If this organ is more extended on the ſides, it forms that of the love of glory; an inclination very analogous to pride.

15. *Organ of the Love of Truth.*

The function of the organ which ſhows itſelf at the poſterior and ſuperior angle of the parietals is not entirely fixed by

Dr. Gall: he, however, has ſome reaſons for conſidering this angle as the ſeat of the organ of the love of truth, but he has not yet collected a ſufficient number of facts to be fully convinced of it.

[We find ſome difficulty in being perſuaded that there is any truth in regard to this function aſcribed by Dr. Gall to the laſt-mentioned organ. It appears to us that an organ placed in the middle of thoſe with which animals as well as men are provided, cannot be deſtined to a faculty ſuch as truth, which belongs only to the latter.

However, the caſe with this faculty is perhaps the ſame as with that of pride, which in animals undergoes a great modification: and we confeſs we have ſeen two men, one of whom, diſtinguiſhed by great veracity, was furniſhed with this organ in the higheſt degree; whereas the other, who had a moſt extraordinary propenſity to falſehood, was ſo deſtitute of it, that his head at that place inſtead of a cavity exhibited a protuberance.]

In the anterior and inferior part of the frontal bone Dr. Gall has found ſeveral organs the function of which is very important.

During his firſt reſearches he conſidered them as the organs of the different kinds of memory; but finding afterwards that they were not only reproductive but alſo productive, he was induced to conſider them as the organs of a particular ſenſe, and to eſtabliſh on this obſervation the opinion, that memory in general is only the reproductive action of all the organs: imagination, on the other hand, is their productive action.

The ſpontaneous movement of the man who endeavours to recollect ſomething, ſeems to have a relation to theſe organs. He carries his hand, as if involuntarily, to the baſe of the forehead. This action, though not perceived by the perſon who performs it, is however conſtant, and is never confounded with that already mentioned in ſpeaking of the organ of courage.

16. *Organ of the Senſe of Locality.*

The organ of the ſenſe of locality occupies the anterior part of the frontal bone which correſponds to the protuberances above the orbits (*protuberantiæ ſupra-orbitales*); it generally accompanies thoſe crania which are diſtinguiſhed by large frontal ſinuses, and which always exhibit in the inſide a cavity correſponding to an eminence of the brain.

When it acts reproductively it conſtitutes what we call the memory of locality (*memoria localis*); on the other hand, when

when it acts productively it determines the combinations of new localities.

It is this organ which directs the blood-hound, in which it is very ſtriking: it exiſts in all the birds of paſſage: it invites them to change their place of reſidence; to undertake diſtant voyages; and to find again their former place of habitation: the ſtork and ſwallow are provided with it in an eminent degree, and theſe are the animals which migrate to the greateſt diſtance from our countries. Men furniſhed with it are obſerved to have a ſtrong remembrance of places, and a deſire for travelling: it is therefore always found in able landſkip painters.

"A general who arranges his army, and who with one look muſt obſerve all the localities of the country which it occupies, cannot diſpenſe with this organ." Of this, the great Frederick was a ſtriking example. At an advanced age this organ is one of thoſe which gradually decreaſe: it is known alſo that memory of every kind, and imagination, are loſt as a man grows old: the frontal ſinuses are then increaſed interiorly; the action of the brain no longer oppoſes ſo much reſiſtance to their expanſion.

17. *Organ of the Senſe of Facts* (Senſus Rerum).

The ſenſe of facts has its correſponding organ in the inferior and anterior part of the frontal bone, in the middle of and below the preceding: it acts productively and reproductively, and in the latter caſe it ſupplies a remembrance of facts and of things.

It is an organ very neceſſary for education and inſtruction, which abſolutely require that one ſhould remember things paſt: in old age it is ſubject to the ſame changes as the preceding.

Among animals the elephant is particularly diſtinguiſhed by the expanſion of this organ. This animal remembers, with the greateſt accuracy, every circumſtance and fact which has any relation to it.

Among men we have found this organ not only in thoſe who had a great deal of memory in regard to facts and things, but alſo in thoſe who might be called ſyſtematic heads, who arranged facts in order, and deduced concluſions from them; and in thoſe who had a ready conception, and who diſtinguiſhed themſelves by a deſire of knowing every thing. It even appears to us that the operation of combining facts to deduce from them a reſult is one of the principal actions of this organ: the elephant, at leaſt, which keeps in its trunk water to beſprinkle, as it paſſes, the perſon who offended it

the preceding evening, arranges several facts, and deduces from them a result which is a real logical conclusion; and we are acquainted with no other organ in the elephant to which this action can be referred.

The automatous motion of a man who perceives that he has acted wrong, seems to support these conjectures: he strikes the middle of the forehead with his hand.

18. *The Organ of Painting and of the Sense for Colours.*

The organ of the sense for colours or of painting occupies the anterior part of the frontal bone below the orbit. Dr. Gall has observed this organ in all painters of great talents.

"As this discovery did not reach us till lately, we have been able to collect only a small number of observations: we have, however, observed it in some individuals; and it is very apparent in the head of Raphael, in the National Museum, No. 57."

19. *Organ of the Sense for Numbers.*

The organ which corresponds to the inferior and exterior part of the frontal bone near the zygomatic apophysis of that bone has the function of the sense of numbers: it exists in men who have a retentive memory for numbers, and in arithmeticians, who perform with great facility the combinations of calculation: it exists in that kind of pie which has the faculty of counting as far as nine; the only instance known among animals.

"We had occasion to observe this organ on the head of a blind person at the Quinze-Vingts, who is distinguished by his arithmetical talents; and Dr. Gall has in his possession the busts of several men which furnish very instructive examples."

20. *Organ of the musical Sense.*

Below this organ is that of the musical sense, or sense of sounds. It acts in the same manner as the other organs, productively and reproductively; it gives a memory for recollecting sounds; it facilitates new combinations of musical compositions; it incites the birds to sing: it acts in those which are learning to speak, and whose language is founded only on this remembrance of sounds.

It is absolutely wanting in animals which have no musical sense; it is very apparent in the parrot and starling; and the great musicians Gluck, Mozart, Haydn, and Pleyel, furnish striking examples of it.

21. *Organ of the Sense for Mechanics.*

In the lateral and inferior part of the frontal bone is placed the organ of the sense for mechanics. The castor, which constructs

ſtructs edifices, is endowed with it in an eminent degree: it exiſts in the field-mouſe, and in birds which build their neſts with a great deal of art: it is found in men who have a talent the mechanical objects, who conſtruct with eaſe any kind of machine, and who diſtinguiſh themſelves in the different arts that require manual labour. Though it be very difficult to judge of the exiſtence of this organ when it is only moderately expanded, "becauſe the *temporo-maxillary* muſcle covers this part of the cranium, it is very eminent if the faculty exiſts in a ſuperior degree; and it is then one of thoſe organs reſpecting which there can be the leaſt doubt."

22. *Organ of verbal Memory.*

In the interior of the orbit at the bottom of the ſuperior part is the organ of verbal memory; it may be obſerved at the time of its expanſion by the influence it has on the poſition of the globe of the eye, which it always puſhes forwards, and more or leſs without the orbit.

Perſons provided with this organ eaſily retain words in their memory. Dr. Gall, when young, remarked this faculty in ſeveral of his ſchoolfellows, who were not only diſtinguiſhed for this talent, but alſo for very protuberant eyes. This was the firſt obſervation, which afterwards gave a direction to all his reſearches. A great many obſervations in regard to this organ have ſince confirmed the truth of its exiſtence and of its function.

23. *Organ of the Senſe for Languages.*

The organ at the exterior and ſuperior part of the orbit is called by Dr. Gall the organ of the ſenſe for languages. Its preſence has a conſiderable influence on the poſition of the globe of the eye: it forces it downwards and towards the noſe, and increaſes its diſtance from the ſuperior edge of the orbit: in animals it does not exiſt, and therefore in the latter the globe of the eye is directed more towards the exterior and lateral part of the orbit.

Its expanſion is always accompanied with a diſtinguiſhed talent for languages; it is very ſtriking in great philologues; and though it be difficult to judge externally of its exiſtence, we have obſerved that it has never eſcaped the acute eye of Dr. Gall, and that, in regard to this point, he has never once been deceived.

24. *Organ of Memory for Perſons.*

The function of the organ at the upper and interior part of the orbit has not yet been diſcovered by Dr. Gall; but ſeveral

observations on man and animals, such as the dog and horse, have induced him to suppose it to be the organ of memory for persons. Its expansion, like that of the preceding, must have an influence on the position of the eye; it must contribute to remove it from the upper edge of the orbit, and to push it towards the exterior and lateral part, if an equal expansion of the preceding organ does not counterbalance its effect.

25. *Organ of Liberality.*

The organ of liberality is placed in the anterior part of the frontal bone, above those of the sense of locality and of the sense for painting (16 and 18), and close to the musical sense (20): a very great expansion of it accompanies prodigality: it is wanting in misers, and in these this part of the frontal bone exhibits a cavity. Dr. Gall has in his possession numerous examples of it.

"The proximity of the organ of music and of the sense for painting (18 and 2) seems often to favour the expansion of that of liberality; and this, perhaps, is one of the reasons why we so often find prodigals among those men who excel by their talents for these two arts."

We constantly observe, that the older a man grows the more niggardly he becomes: at an advanced age, therefore, the diminution of this organ is so striking, that it sometimes gives rise to a very considerable extension of the frontal sinuses.

26. *Organ of the Spirit of Comparison.*

The organ above the sense for facts in the middle of the forehead is destined for a faculty which Dr. Gall calls the comparative spirit (*judicium comparativum*). It forms an oblong eminence, and is found in men who in speaking have a ready command of figures or tropes; who are not at a loss for expressions; who relate well, and have a great deal of loquence.

27. *Organ of the metaphysical Spirit.*

If this organ is more expanded towards the sides, so that it forms a round eminence which rises in the middle of the forehead, it indicates a metaphysical spirit. Among the busts of the antient philosophers that of Socrates in particular affords one of the most striking examples of this organ. Among the modern philosophers, I shall mention only Kant, as one of the most celebrated.

[I recollect that the forehead of one of my first schoolfellows, whom we styled the philosopher, on account of his attachment

tachment to the abſtract ſciences, exhibited a very ſenſible expanſion of this organ.]

28. *Organ of the Spirit of Obſervation.*

The organ of the ſpirit of obſervation extends over the whole anterior part of the frontal bone, and its expanſion brings the forehead nearer, in a greater or leſs degree, to the vertical line. It is found in particular in the crania of the obſervers of all ages. The celebrated phyſician Frank is endowed with it in an eminent degree; and Dr. Gall himſelf is evidently furniſhed with it.

29. *Organ of the Spirit of Satire.*

The organ of the ſpirit for ſatire and wit (*witz* of the Germans, and *facetiæ* of the French,) correſponds to the frontal protuberances. Dr. Gall obſerved ſeveral examples which prove the truth of this opinion; and we have never found it to fail.

30. *Organ of Mildneſs.*

The organ of mildneſs is ſituated in the middle of the forehead above that of the ſpirit of compariſon (26). It forms that oblong elevation which is conſtantly found in the heads of Chriſt and Mary painted by Raphael and Coreggio, and greatly contributes to give them an engaging character of mildneſs and benevolence: it always accompanies the crania of men naturally mild, and is wanting in thoſe who are malevolent and revengeful *.

Among animals, the roe-buck, hind, pigeon, &c. are provided with it: on the other hand, it is wanting in animals of prey, ſuch as the eagle, ſtarling, tiger, fox, &c. The frontal bone, then, inſtead of being arched and elevated, is depreſſed and hollow.

31. *Organ of Theatrical Talents.*

A very ſtriking enlargement of the ſummit of the frontal bone ariſes from the expanſion of the organ for repreſenting ſentiments by geſtures, or of theatrical talents.

" Dr. Gall has collected many obſervations which prove the truth of this opinion; and it cannot fail to be obſerved by thoſe who examine with attention the heads of the great actors of the different theatres of Paris."

[We think we have obſerved alſo that this organ is particularly expanded in the deaf and dumb; and this we aſcribe to the neceſſity which theſe perſons are under of keeping it in

* That mildneſs which reſults from the principles of morality is not here meant, but that which exiſts by inſtinct, without being the conſequence of moral reflection.

 continual

continual action—an exercise which must necessarily favour the improvement of it.]

32. *Organ of Theosophia.*

The organ of theosophia occupies the most elevated part of the frontal bone. All the representations of the old saints preserved to us afford very instructive examples; and if there be one destitute of this character, it is certain that it is also void of expression.

An *excessive* expansion of it is observed in religious fanatics, and in men become religious by superstition. It is the seat of this organ which, according to Dr. Gall, has induced all nations to consider their gods as above them in an elevated place in the heavens. When we consider, indeed, this object with a philosophic eye, there is no more reason for placing the deity above the globe than below it.

33. *Organ of Perseverance.*

The last of the organs hitherto found by Dr. Gall is that of perseverance, constancy, and firmness of character: it is situated at the anterior and superior part of the parietals in the middle of the head. When it exists in excess it gives obstinacy; and inconsistency is the consequence of a want of it.

"In regard to those parts of the cranium in which Dr. Gall has not yet found organs, it is probable that his further researches will some day enable him to discover more; and the work he intends to publish will furnish us with further details on the subject. It belongs therefore to him to convince us, in an incontrovertible manner, of the truth of his system, a detail of which cannot be satisfactory in a treatise so incomplete."

We find it necessary to remark also, that all the organs here enumerated cannot be distinctly perceived but in individuals who possess any faculty in an eminent degree; and that it is impossible to judge properly of a moderate talent, when its organ is too much confounded with the neighbouring ones.

"In regard to the objections made to the system of Dr. Gall, that it *leads immediately to materialism*, we do not see the philosophical reasons on which it is founded. Even if we suppose organs for the interior faculties, the immense distance between thought and matter still remains the same; objects of so heterogeneous a nature are not susceptible of being classed together. Besides, the will still remains entire: it is it which ought to counterbalance the action of the organs; and the passions ought to be restrained by morality.

XXII. *Letter from Count* Morozzo *to* C. Lacepede, *Senator and Member of the French National Institute, on an Ichneumon brought from Egypt* *.

In the middle of April 1802, C. Aimet, chef de bataillon in the corps of engineers, brought to Rome a young ichneumon which he had caught in Egypt. I took the earliest opportunity of examining it; and, as I made some very interesting observations in regard to the natural history of this animal, I communicate them to you with pleasure.

The Greeks and the Romans called it the *ichneumon:* it is the *mangouste* of Buffon, and the *mus Pharaonis* of Prosper Alpinus. It is a pretty animal, about the size of a cat, with a long tail; its hair is rough and of considerable length; it cannot be compared to any thing better than the bristles of the wild boar. It is radiated transversely with three colours, viz. grayish white, fawn or russet colour, and black. Each hair has five or six transverse rings, like the quills of the porcupine: the length of these hairs from the body is an inch or an inch and a half; they are shorter on the tail, and in particular at the head, which gives to the animal a neat appearance.

The head, and particularly the muzzle, are very small; it has beautiful teeth like those of the dog; two canine, six incisive teeth, and eight grinders in each mandible, making in the whole thirty-two. It has small ears of a brown colour without hair; they adhere to the head like those of apes. Its eyes are small and lively. An observation which I made in regard to the eyes will be mentioned hereafter.

Its colour varies a great deal according to the place in which it is viewed. When observed towards the side of the head it appears to be grayish black; when looked at behind, it appears to be reddish. The legs, and particularly those before, are short: it has five toes on each foot, four before and one smaller behind. The two middle toes on each foot are longer. The nails are black, like those of the dog.

The young ichneumon is very familiar and domestic: it is fond of being caressed; it is much afraid of cold; and though the temperature of Rome is very mild, it was gratified by having a covering now and then thrown over it; sometimes even a chaffing-dish was placed near it. Very often it lies down in a round form on a chair or on the bed, which it

* From the *Journal de Physique, Messidor,* an. 10.

it leaps upon with great agility, and conceals its head between its thighs to keep itſelf warm.

This individual is a female: it has below its parts of ſex a large bag, which has been deſcribed by all naturaliſts: it is aſſerted that during the great heats it opens this bag in order to cool itſelf. Jonſton gives a very good deſcription of this conduit, which is as follows:—"Meatum denique extra foramen excrementi peramplum, undique pilis cinctus, pudendo muliebri non diſſimilem, quem magno urgenti cætu operiri ſolet. Hinc ſcriptores omnes indiſcriminatim ichneumones et mares et fœminas arbitrati ſunt *." From this conduit an odoriferous liquor diſtills: the individual in queſtion, on the approach of a dog, opens this bag, and the dog immediately retires: no odour however is perceived at the time. The meaſurement of the different parts, which I took from the animal itſelf, is as follows:

	Foot.	In.	Lin.
Whole length from the muzzle to the extremity of the tail - - -	2	5	3

It wanted, however, a ſmall bit at the extremity of the tail, which ſeemed to have been cut off, and which may be eſtimated at an inch or an inch and a half †.

Meaſures in Detail.

	Foot.	In.	Lin.
Length of the head - - -	0	4	4
Length of the body - - -	1	2	5
Length of the tail - - -	0	10	6
Total	2	5	3

	Foot.	In.	Lin.
Circumference taken at the thickeſt part of the body - - -	1	0	4
Circumference of the muzzle below the eye	0	4	6
Height of the fore-legs - - -	0	5	2

The figure given by Buffon is very good, and has a perfect reſemblance to the individual here deſcribed. The figure of Aldrovandi is alſo very correct. The caſe, however, is not the ſame with thoſe of Jonſton and Proſper Alpinus.

In regard to the deſcription which Buffon has given of the mangouſte, it is traced out with the ſame pencil which has ſo well delineated the other animals: he has ſeparated fable

* Jonſton Hiſt. Animal. quad. p. 105.

† Kæmpfer, in the deſcription which he gives of the ichneumon or mangouſte in his *Amœnitates Exoticæ*, p. 574, ſays that it was two feet and a half in length from the head to the extremity of the tail.

from

from hiftory, and has defcribed its habits with great propriety. Two obfervations, however, which I had an opportunity of making, and which appear of importance, feem to have efcaped him.

1ft. That the animal has a kind of interior eye-lid, which paffes over the globe of the eye as in nocturnal birds; but with this difference, that in the eye of owls this membrane rifes and falls in a direction which I would call perpendicular from the bill to the fummit of the head, while in the individual in queftion it proceeds laterally from the noftrils to the ear; which induces me to believe that the animal feeks its prey in the night-time. By means of this interior eye-lid it contracts the pupil at pleafure, and it muft then fee in obfcurity, like the cats; but in the latter the pupil is leffened and dilated by contraction; whereas in this animal the fame thing is effected without contraction, and, as we may fay, by mechanical means.

2d. That the four toes of the fore- as well as hind-feet are connected to each other by a brown membrane without hair, fuch as that of amphibious animals. I extended its toes and examined this membrane, which is folded backwards, fo that when the animal walks it is not feen. This certainly indicates that the animal fwims with great facility.

This character proves that it ought to be claffed among amphibious animals. Jonfton fays of the ichneumon:—"Amphibium eft animal et ad Niloticas ripas commoratur." Aldrovandi alfo confiders it as amphibious: his words are: "Ab ordinis ratione non effe alienum opinamur, fi poft lutram ichneumonis hiftoriam recenfeamus, quoniam et ipfe inter animalia *αμφοιεριζαυτα*, id eft promifcua in aquis et terrâ degentia, reponamur, ideoque a nonnullis lutra Ægypti nuncupatur*." He quotes alfo Strabo, who is of the fame opinion. "Strabo quoque hanc belluam aquatilem confiftere videtur."

However, though thefe refpectable authors have confidered this animal as amphibious †, none of them have mentioned the fkin on its feet, which forms a kind of fins. Ariftotle, Pliny, and Profper Alpinus, are equally filent refpecting it. Though this character feems very effential in the defcription of an animal which frequents the banks of rivers; while, on the other hand, they have carefully noticed this peculiarity in the feet of the otter and in thofe of the caftor. After what

* Aldrovandi de quad. dig. p. 298.

† I take the word *amphibious* in the fame fenfe in which it was taken by the antients; for this term, ftrictly fpeaking, can be applied only to the family of the *phocæ*.

has

has been here ſaid, will it be aſſerted that this is not the caſe? By no means; for there is no oppoſing facts.

Buffon in his deſcription of this animal exclaims againſt nomenclators and generic denominations. I know that ſcience will make little progreſs when people are prejudiced in favour of their ſyſtems; but there are certain characters ſo ſtriking in ſome animals that no error can be committed in claſſing them. He reproaches Linnæus with having made the ichneumon at firſt a badger, then a ferret; yet it certainly belongs to neither of theſe ſpecies.

Had he obſerved that ſkin or ſort of fins which it has on its feet, he would certainly have claſſed it among the amphibious quadrupeds after the caſtors and beavers, which have a ſimilar membrane between their toes. Klein calls it *lutra Ægypti* *; but he does not ſpeak of fins. Beſides, as the ichneumons frequent the banks of the rivers in Egypt, where they ſearch in the ſand for the eggs of the crocodile, of which they are exceedingly fond, or go in queſt of thoſe ſerpents which the Nile leaves among the mud after its inundations, they muſt be obliged to croſs, by ſwimming, ſome arms of the river or ſome canals in order to find their prey. For this reaſon nature has provided them with fins, and the conformation of the eye induces me to believe that they muſt alſo ſearch for their food in the night-time. To this fact I ſhall add the decided taſte which the individual in queſtion has for fiſh, which ſeems to prove that the ichneumon in its wild ſtate eats this food.

As this animal will ſoon be at Paris, you will be enabled to examine it yourſelf, and to verify my obſervations. I have no doubt that others will be brought from Egypt: you can examine whether the peculiarities I have deſcribed be common to all ichneumons, or belong only to ſome families.

If this animal ſhould unfortunately die before it arrives at Paris, for it has ſuffered a great deal by the change of climate, and theſe animals, beſides, do not live to a great age, you will ſee the beautiful picture of it which M. Aimet cauſed to be executed by M. Peter, an excellent artiſt in this department, who has repreſented it with the greateſt exactneſs poſſible. Two figures of it are delineated under two points of view. M. Peter kept it at his houſe for a fortnight, to ſtudy its deportment and attitudes, in order that he might be able to give a correct repreſentation of it.

* De quadrup. p. 66.

XXIII. *Of*

XXIII. *Of the State of Vapour subsisting in the Atmosphere.* *By* RICHARD KIRWAN, *Esq. LL. D. F. R. S. and P. R. I. A.* *

VAPOUR or moisture in the atmosphere may subsist in dense air, or in air highly rarefied: that it is found in the former is well known, and that it may subsist in the latter appears by the observations of Bouguer; for he saw clouds three or four hundred toises above Chiromboracho, and consequently at the height of twenty-two thousand five hundred and twenty-eight English feet, or 4·3 miles over the level of the sea; a height at which in the temperature of 32° a barometer would stand at 12·7 inches. At such heights, and at much inferior, since evaporation proceeds much more quickly, it is not to be supposed that all the vapour so rapidly produced is dissolved in the ambient air, but part rises uncombined, as it does under an exhausted or half-exhausted receiver, and in this case Mr. De Luc's system is admissible. This emission of pure vapour seems to begin at heights at which the density of the air is 25, (that is, at heights at which the barometer would stand at twenty-five inches, and thus I shall in future express the various densities of air,) at least it is very considerable where the density is twenty. This leads me to treat of the properties and state of pure invisible vapour, namely, its specific heat, elasticity, and specific gravity.

The immortal Doctor Black, the father of all discoveries of this kind, informed me that the vapour of water, boiling at 212°, that is, at 180° above the freezing point, and possessing the same sensible heat as the water, contains nine hundred and forty times more latent heat than an equal weight of water does heated to 212°, or 5·222 times more latent heat than it does of sensible heat, counting from the freezing point, for 180 × 5·222 = 940 nearly. In this case the pressure or density of the atmosphere is thirty, the barometer standing at the height of thirty inches; and with Doctor Black's account the experiments of Mr. Schmidt of Giessen very nearly agree; for according to him the latent heat of the vapour of water, barometer 29·84 inches, and the heat 212°, is 5·33 times greater than its sensible heat above the freezing point: now 180 × 5·33 = 959·4 †. The difference or excess in his experiment proceeds from the pressure of the at-

* From his paper intitled, "Of the Variations of the Atmosphere," Dublin, 1801.

† Gren's Physical Journal, iv. p. 315.

mofphere being fomewhat lower, as Mr. Watt's experiments prove.

Mr. Watt difcovered that the latent heat of fteam diminifhed in proportion as its fenfible heat increafed, Phil. Tranf. 1784, p. 335. Now the fenfible heat of fteam exceeds 180° above the freezing point when the barometer ftands above thirty inches, and lefs than 180° when the barometer ftands lower than thirty inches, as Mr. De Luc firft difcovered, and may be feen in Sir George Schuckburgh's and Mr. De Luc's tables, Phil. Tranf. 1779, p. 375. From thefe I have deduced the following table:

Heat of boiling water.	
Bar.	Heat.
30	212°,
29	2[illegible]0·28
28	208·52
27	206·73
26	204·91
25	203·06
24	201·18
23	199·27
22	197·33
21	195·36
20	193·36
19	191·06
18	188·46
17	185·56
16	184·36
15	18[illegible]·86
14	176·70

The accuracy of this table even in the lower part of the fcale is fufficiently apparent by the refult of the experiments of Sauffure on ebullition on Mount Blanc; for on that enormous mountain, the barometer ftanding at 16 French inches or 17·05 Englifh, he found water to boil at the heat of 68·993 of Reaumur, a degree which on Geneva thermometers is equal to 1[illegible]5·56° Englifh.—Hence we fee that diftillation may be more advantageoufly effected on mountains than on plains, and at low barometrical heights than at the greater, yet within certain limits; for, at heights that furpafs 8 or 10 thoufand feet, the fuel, by reafon of the rarity of the air, is more flowly confumed. Hence alfo, from the knowledge of the degree of the heat of ebullition to two or more decimal places, the ftate of the barometer above or below 212° may be inferred to one or more decimal places. The reafon of this rapid diminution of the heat of ebullition below 25 inches is evidently the diminution of refiftance, from the diminifhed weight of the atmofphere, which then is very fenfible: but as the cold continually produced by evaporation is then alfo very confiderable, the *time* neceffary to procure ebullition is longer, as Sauffure remarked on Mount Blanc, Vol. vii in 8vo, § 2011, p. 328. He found the heat of ebullition barometer 16 to be 68·993 degrees, or in Englifh meafures barometer 17·05. 185·5° of Fahr. (counting one of Reaumur at Geneva = 2·225 of Fahr.)

Hence fince, according to Mr. Watt, the fenfible heats of the vapours of boiling water at different barometrical heights are as the barometrical heights reciprocally, and the fpecific heats

heats of the vapours of water boiling are as the sensible heats reciprocally, it being known, that the specific heat of the vapour of water heated to 180 degrees above the freezing point is 940. The specific or latent heat of the vapour of boiling water, whose sensible heat is known, (and it may be known by the barometrical height as shown in the above table and the notes) may also be discovered.

Thus the sensible heat of the vapour of boiling water barometer 30 being 180° above the freezing point ($212°-32°=180°$) and the specific or latent heat of vapour, whose sensible heat is 208·56° (that is 176·56 above 32°) as it is when the barometer stands at 28 inches, is 958 for $\div$ 176·56. 180 : : 940·958 *.

As pure invisible vapour does not in my opinion (of which I have already stated the grounds) exist in the atmosphere when its density is higher than 25, as it is in most of the inhabited parts of the globe, but is always in this case united to air, an inquiry into its latent heat at different temperatures below ebullition were superfluous. But as it does exist in air whose density is 25 or less, since it is found in air whose density is 12·5, it becomes necessary to examine its latent heat in such cases, in all temperatures inferior to that of ebullition. Now, by analogy, I apprehend this latent heat in all inferior temperatures may thus be determined.

As the *sensible* heat of ebullition, when the barometer is at 25 or below 25, is to the *latent* heat of the vapour at ebullition, so is the *sensible* heat of water heated to any inferior degree above 32° to the latent heat of its vapour, multiplied by 5·222. Thus the sensible heat of water in ebullition barometer 25 being 171·4° ($= 203·4°-32°$) its specific heat is 987 $\left(=\frac{169206}{171·4}\right)$ the latent heat of the vapour of water at 22° above congelation (that is 52° on Fahr. scale) is 657 for $\div$ 171·4° 987 : : 22°. 126 $\times$ 5·22 = 657. The latent heat of vapour in such cases cannot be determined by experiment, on account of the admixture of atmospheric air: we must therefore resort to analogy, which in this case is perfect.

The latent heat of pure vapour at greater heights is more considerable: thus at heights, at which the barometer stands at 20 inches, the latent heat of vapour whose temperature is 22° above 32°, as in the last case, is 730; for the heat of ebullition is 194·8°, per table, = 162·8°, above 32°: and the latent heat of the vapour at ebullition is 1039. Now $\div$ 162·8. 1039 : : 22. 140 and 140 $\times$ 5·22 = 730.

* Hence 169206, being the product of 180° $\times$ 940, is the common dividend of all sensible heats *below* 180°, when the latent heat of the vapour is sought at barometrical heights below 30 inches.

As air is cooled by the reception of moisture dissolved in it, we must infer that its capacity for containing heat is increased, and hence moist air is more difficultly heated or cooled than dry air of the same temperature. (For the cold proceeds from the absorption and not from the expulsion of caloric.)

The elasticity or expansive force of pure vapour has been examined at every fifth degree of Reaumur above 0 to 110°, by Mr. Betancourt, and may be seen in an excellent work of Prony's, his *Architecture Hydraulique:* he has by a most ingenious calculation interpolated the expansions answering to the intermediate degrees. But Mr. Schmidt seems to have determined this expansive force still more exactly than Betancourt. Hence I here insert this table, adding Fahrenheit's for Reaumur's degrees, and distinguishing the expansions interpolated by calculation from those actually observed by *I.* The forces are measured by the elevation of a mercurial column in inches and hundreds of a French inch*.

Reaum.	Fahren.	Expansive Force.	Reaum.	Fahren.	Expansive Force.
1	34·25°	·01 *I*	21	79·25°	1·01 *I*
2	36·5	·03 *I*	22	81·5	1·01
3	38·75	·05 *I*	23	83·75	1·19 *I*
4	41·	·07 *I*	24	86·	1·29 *I*
5	43·25	·11	25	88·25	1·30
6	45·5	·15	26	90·5	1·38 *I*
7	47·75	·16 *I*	27	92·75	1·42
8	50·	·20 *I*	28	95·	1·60 *I*
9	52·25	·25 *I*	29	97·25	1·80 *I*
10	54·5	·28	30	99·5	1·93
11	56·75	·34 *I*	31	101·75	1·02 *I*
12	59·	·38	32	104·	1·12 *I*
13	61·25	·44	33	106·25	2·23
14	63·5	·50 *I*	34	108·5	2·40 *I*
15	65·75	·55	35	110·75	2·68
16	68·	·61	36	113·	2·80 *I*
17	70·25	·69 *I*	37	115·25	3·20
18	72·5	·76	38	117·5	-
19	74·75	·84 *I*	39	119·75	3·40
20	77·	·90	40	122	3·64
			80	212·	28·

* The Paris cubic inch = 1·21 English. Now the English cubic inch of mercury when its specific gravity is 13·6 weighs 3443·2 English grains: therefore the Paris inch weighs 4186 English grains, and 1-10th of this inch = 418·6 grains: and 1-100th of this inch 41·86 grains.

Note.

Note.—1°. Moſt of the interpolations from the 88th degree to the 122nd I have myſelf inſerted, as thoſe calculated by Schmidt erred too widely by his own account.—Gren's Phyſ. Jour. iv. 273.

2do. Mr. Pictet has alſo made a ſet of curious experiments on the elaſticity of pure vapour in low temperatures. *Eſſais de Phyſique*, p. 157. He found that a grain of warm water in *vacuo* evaporates in forty minutes in the temperature of 38° Fahr. under a receiver containing 1452 Engliſh cubic inches *, but that it did not diffuſe itſelf equally in leſs than ſix hours, and then raiſed the hygrometer from 17° to 60°, that is 43°; and during this whole time the cold under the receiver was conſtantly decreaſing, though ſlowly; which decreaſe undoubtedly contributed to the diffuſion of the vapour.

Mr. Schmidt has alſo made a ſeries of experiments upon the dilatability of air, made as *dry* as poſſible by expoſure to hot tartarin—an object of great importance, that had never before been examined. This table I here inſert, converting Reaumur's degrees into thoſe of Fahr. and adding from his formula the degrees he omitted.

Reau.	Fahren.	Expanſion of one inch at 32°.	Reau.	Fahren.	Expanſion of one inch at 32°.
1	34·25°	·0044675		79·25°	·0938175
	36·5	·0089350		81·5	·0982850
	38·75	·0134025		83·75	·1027525
4	41·	·0178700	24	86·	·1072200
	43·25	·0223375		88·25	·1116875
	45·5	·0268050		90·5	·1116155
	47·75	·0312726		92·75	·1206225
8	50·	·035740	28	95·	·1250909
	52·25	·0402075		97·25	·1295557
	54·5	·0446750		99·5	·1340250
	56·75	·0491425		101·75	·1384925
12	59·	·0536100	32	104·	·1429600
	61·25	·0580775		106·25	·1474275
	63·5	·0625450		108·5	·1518950
	65·75	·0670125		110·75	·1563625
16	68·	·0714800	36	113·	·1608300
	70·25	·0759475		115·25	·1652975
	72·5	·0804150		117·5	·1697650
	74·75	·0848825		119·75	·1742825
20	77·	·0893500	40	122·	·1787000
				212·	·3574000

* Ibid. page 91.

Note —1°. Hence we see that 1000 inches or measures of dry air at 32° would become 1004·4675 at 34·25 Fahr. and at 50° would become 1017·87. Hence 1000 measures of *dry* air gain 1·985555, &c. by each degree of Fahr. above 32° (or more compendiously 1·9856, which is true to two decimal places) or nearly two.

2do. We see the source of the discordant results of D'Amontons, De Luc, Lambert, Schuckburgh, Roy, Berthollet, and Monge, &c.; for they all operated upon air more impregnated with various degrees of moisture; besides taking the boiling point at different barometrical heights; in the present experiments it was taken at 29·841 English inches.

3tio. It appears that the expansions are as the differences of heat above 32°, as D'Amontons, Lambert and Schuckburgh also noticed; though their experiments, not being made on perfectly dry air, could not be very exact.

[To be continued.]

XXIV. *Some Conjectures respecting the Origin of Stones which have been observed to fall from the Clouds. By* William Beauford, *A.M.**

THE falling of stones from the clouds, a natural phænomenon not generally understood, is by no means a novel circumstance in the history of nature. Several stones were observed to fall from the clouds in Yorkshire in 1360, in Bohemia and Saxony in 1480, in Bohemia about 1753, in Sienna in 1794, in Portugal in 1796, in Yorkshire in England in 1795, and near Benares in the East Indies in 1798. From an analysis made of these stones by the French academicians in 1768, and by the Royal Society of London in 1802, they are all found similar in their component parts to each other, but dissimilar to all bodies found in mines and quarries, being composed principally of four kinds of substances: the first being in the form of dark grains, composed of silex, magnesia, iron, and nickel; the second, a kind of pyrites; the third, metallic iron; and the fourth, a gray earthy substance which serves as a cement to the others, and with which they were coated. From these compositions the matter seems to be of volcanic origin; yet it is difficult to conceive how stones of any considerable magnitude could be thrown at such a distance from any volcano as those found in Bohemia, Saxony, and Britain. The nearest volcanos to Britain are those of Vesuvius, Ætna, and Hecla: a stone to be thrown into Bri-

* Communicated by the Author.

tain

tain from any of these, would require an impetus of between 3 and 400 miles; and, if allowance be made for the resistance of the air, 1200 under the greatest range of 2400 miles; a force not known to exist on the earth. It is true, volcanic ashes, when collected in the upper regions, will be carried by the clouds to an amazing distance. But these are small light ashes, not stones. It is evident, therefore, if these substances originate from volcanic ashes, they must be formed in the clouds, where those ashes, meeting with carbonic, sulphuric, and other acids, and mixing with earthy particles drawn from terrestrial objects, are, by the electric fluid in the lightning, precipitated from the aqueous vapours which bore them up, and, becoming united, fall to the earth in the form of stones; as in some measure is evinced from the flashes of light and detonation which accompany their fall.

Substances, also of the same nature may be formed in the clouds without the assistance of volcanic matter; for the carbonic, sulphuric, and aqueous vapours, which rise from mines, furnaces, bogs, vegetables, and animals, and the small particles of siliceous and calcareous earths which collect in the clouds, are decomposed or made to assume new arrangements by the electric fire, whereby the minerals are generated and united to the earths, and consequently fall in the form of stones. Thus stones, by means of electricity, are formed in the clouds from the ferriferous principles ascending from volcanos, mines, and furnaces. Britain, indeed, is too far from any volcano to suppose that any quantity of volcanic matter can be wafted by the winds to this island; yet it contains a number of ferruginous mines and furnaces employed in the manufactory of that metal; from which proceeds an immense quantity of gas, containing the ferriferous matter, and such matter as is generally connected with it. Besides, there is a circumstance not generally attended to by mineralogists — that all mines of whatever nature contain a mineralogical atmosphere replete with the generic principles of the metal contained in the respective mines. That Nature, by her slow but regular operations, is daily producing metals from their elements, will hardly be denied; and whether the atmosphere of which I speak be produced by exhalations from the ingredients she employs, or a part of the ingredients themselves, the case will be the same as to the object I have in view. This atmosphere has a strong and visible effect on the stones and vegetables which cover the soil, especially that which covers mines of iron, lead, and copper. Animal and vegetable exuviæ, and other decayed mundics, arising from bogs, morasses, and dirt-hills, produce a great quantity of carbonic

 and

and fulphuric gafes, containing the generic principles of iron, magnefia, and nickel, &c. : thefe, uniting with filiceous, argillaceous and calcareous earths, produce in great quantities that fpecies of iron ore termed bog ore, and that in much greater quantities than is generally imagined. Thefe ores are produced in lumps from 40 to 100 lbs. and more in weight, containing from one-fourth to one-half of pure metallic iron, intermixed with pyrites and vitrified fubftances refembling glafs and petrified fhells, the inhabitants of frefh-water lakes. Whence it is evident that a number of petrifactions and mineralizations are performed by water and air affifted by the electric fluid alone; and a number of the operations of nature have been attributed by philofophers to the effects of fire, and deemed volcanic, which are the effects of the aqueous and pneumatic elements.

In order to afcertain in fome refpects the truth of this propofition by experiment, I caufed a quantity of gas, liberated from water by means of fteel filings and vitriolic acid, to be received in a glafs veffel, to which was added carbonic acid from the fumes of charcoal and fulphuric gas, with the fine duft of chalk and earth, until the whole appeared a dark thick cloud. The electric fpark being then paffed through it, a flafh of light and a fmart detonation enfued. After this operation the cloud became more tranfparent, leaving at the bottom of the veffel a quantity of water, with a gray powder, evidently metallic, mixed with earth. If the experiment had been performed on a larger fcale, and the ingredients varied, the refult might have been more decided, and the phænomenon more accurately demonftrated.

This is a fubject that merits every philofophic inveftigation. The magnitude of the ftones undoubtedly depends on the quantity of generating matter, and the height from whence it falls; yet, how ftones of fuch a weight as that which fell in Yorkfhire could be formed in the air, might be a fubject of doubt, if the fubftance had not been found of the fame nature as thofe which fell in Bohemia and Sienna. But it ought to be confidered that thefe fubftances are not formed inftantaneous in the clouds: the conftituting matter, precipitated by the electric fhock, is thrown by the explofion to a point, when, from the action of the air in falling, it becomes enveloped in the terra cementium with which the matter is mixed. Whence, the greater the height or range the matter has to pafs through from the time of the electric fhock, the larger will be the ftones. Moft if not all the meteors formed in the air even at great heights probably originate from one caufe: thofe which contain the larger

portion

portion of inflammable air take fire at the electric shock, and produce those luminous and fiery meteors so astonishing to mankind; while those which contain less inflammable matter, but a greater quantity of the ferriferous principles, are formed into fire-balls or ferruginous stones of different magnitudes, which descend on the earth; whilst the more light, or those which are composed only of inflammable gases, mount into the upper regions of the atmosphere, where, taking fire, they fly off in luminous vapours. The height to which some of these vapours are carried before they are decomposed is amazing; reaching into regions where we should imagine the atmosphere would not be of sufficient density to sustain them. But the natural history of the terrestrial atmosphere has not yet been fully investigated; nor the power and effects of electricity in the formation of lithological, mineralogical, vegetable, and animal substances;—subjects that demand the attention of the most able chemists and sagacious philosophers.

Dublin,
Sept. 16, 1802.

XXV. *On the Hydrometer.* *By* William Speer, *Esq.* *Supervisor and Assayer of Spirits in the Port of Dublin**.

THE hydrometer, or areometer, as it is called, is an instrument which ascertains the density of liquids, weighing unequal masses with the same weight.

This instrument is of great antiquity, and until lately it was supposed to have been invented at the end of the fourth century, by Hypatia, the daughter of Theon, the celebrated mathematician of Alexandria: but M. Usebe Salverte, in a memoir on this subject, in the *Annales de Chimie*, vol. xxii. has demonstrated its having been invented by Archimedes three hundred years before the period in which Hypatia was born; and the very elegant Latin description he gives of this instrument, from an author of great antiquity, shows that, in the form, several of those now in use differ but little from that of the original invention.

This instrument, from the facility and expedition with which it may be applied, has long been in use for ascertaining the specific gravity of various kinds of liquids; but its application to the particular purpose to which it is now used is comparatively of modern date.

* Extracted from his "Enquiry into the Causes of the Errors and Irregularities which take place in ascertaining the Strengths of Spirituous Liquors, &c. London 1802."

Until within a period of about forty years, the ſtrengths of ſpirituous liquors were moſtly aſcertained by other modes, both in Great Britain, Ireland, and on the Continent.

Proof by oil, by agitation, by firing gunpowder, by alkaline ſalts, and by glaſs bubbles, has been uſed, but in every caſe found defective; and the hydrometer was at length reſorted to, as an inſtrument calculated to aſcertain theſe ſtrengths with leſs trouble and greater accuracy.

To obtain indications of ſtrengths by it correctly, however, depends on circumſtances that have not, until lately, been ſufficiently underſtood or aſcertained; on which account the inſtrument has been complicated in various ways, by weights and ſliding rules: theſe, in ſome caſes, have rather increaſed than diminiſhed its irregularity.

The object of the following inquiry is therefore to bring into one view all the cauſes of thoſe imperfections and irregularities, and, by ſo doing, to prepare the way for their removal.

Thoſe irregularities have ariſen from ſeveral cauſes. In the firſt place, when Clarke's hydrometer was conſtructed (forty years ago), the effects of expanſion by heat, and contraction by cold, on the ſpecific gravity of ſpirituous liquors, had not been accurately aſcertained; nor was the diminution of bulk by penetration (or concentration, as it is improperly called,) well underſtood.

In this ſtate of ignorance of theſe effects, Clarke's hydrometer was conceived to be a great improvement on that which had been in uſe before it. Preciſely the ſame kind of advance in improvement had been made in the Iriſh hydrometer, ſomewhat nearly about the ſame period. The duty on ſpirits in both kingdoms previous to this time was paid only on two denominations, viz. ſingle and double ſpirits; the former was proof, or under it, and the latter all ſuch as were over proof; and this diſcrimination of ſtrength was made either by a rude ſort of inſtrument which hardly deſerved the name of hydrometer, or by dropping oil into the ſpirit: if the oil floated, it was called ſingle; if it ſunk, it was double.

The preſent Iriſh hydrometer was adopted about two or three years after Clarke's hydrometer in England; both of which purporting to diſcriminate the increaſe of ſtrength by *per centages* *, ſo as to proportion the additional rate of duty to

* As this term occurs frequently in the following eſſays, and may not, perhaps, be clearly underſtood by all my readers, it may not be amiſs to explain it here:—A ſpirituous liquor is ſaid to be ten per cent. over hydrometer proof when it is ſo ſtrong that one hundred gallons of it will admit

to the relative increafe of overproof, were confidered great improvements; and though, from the conftruction of Clarke's hydrometer, it was evident that the variations occafioned by change of temperature were then *fomewhat* known; yet in Ireland the effects of thefe variations were conceived fo immaterial, and the numerous weights attached to this inftrument, the difficulty of underftanding it, the certain delay and probability of miftake, were confidered to be fo objectionble, that it was deemed better to ufe an hydrometer which paid no regard to temperature, than to ufe one liable to fo many other objections. The variations by the ordinary change of temperature being, however, from one to fifteen *per cent.*, this defect in the conftruction of the Irifh hydrometer is fo manifeft, that it is prefumed it would be a wafte of time to attempt any demonftration of its incompetency.

Although Clarke's hydrometer has not been conftructed without a reference to temperature, yet this has been attended to only in part; and the inftrument being otherwife very defective, it will be neceffary to exhibit thefe defects, in order that they may be guarded againft in fuch hydrometer as fhall be adopted inftead of it.

Till Clarke's hydrometer was adopted, which, from the beft information I can obtain, took place about the year 1762, proof fpirit was made by mixing equal portions of water and the ftrongeft fpirit which could be procured: but it being fometimes difficult to obtain this proof fpirit for comparifon, fuch a mixture was made by order of the honourable board of excife; and it was found, that when fix gallons of it were mixed with one gallon of water, a wine gallon of the mixture weighed feven pounds thirteen ounces avoirdupoife: the board therefore declared, that the fpirituous liquor, of which the gallon weighed feven pounds thirteen ounces, fhould be reckoned one *to* fix, or one *in* feven *under* proof.

This definition of proof was adopted in order to accord with a mode of examination which had been long in ufe, and fanctioned by the board.

The hydrometer faid to be invented by Mr. Clarke * was at

admit an addition of ten gallons of water to reduce it to the ftrength of proof; and it is faid to be ten per cent. under proof when one hundred gallons contain ten gallons of water more than proof contains.

* In 1772 the States of Languedoc offered a premium for the beft memoir on the fubject of afcertaining the ftrength of brandies. This premium was adjudged, by the Royal Society of France, to M. Bories, M. D. whofe inveftigation and experiments on this difficult fubject have, I humbly conceive, been furpaffed only by thofe of the Royal Society in this country. Speaking of the various methods he had tried, he fays: " J'eus recours

at this period brought forward, which having a ſet of weights correſponding to the above-mentioned mixture of water and proof ſpirit, and the mixture of one *to* ſix, or one *in* ſeven, being that only which weighed an exact number of pounds and ounces, without a fractional part, per gallon, by the ſtatute of the 2d of George III. this obſcure mode of aſcertaining proof was adopted. At this time, the effects of heat and cold, on the trial of the ſtrength of ſpirits by the hydrometer, had not been clearly underſtood; and though Clarke's hydrometer, which was then adopted, by having, in addition to the weights uſed for aſcertaining the ſtrengths of ſpirits, another ſet of weights called weather weights, adapted to ſeveral temperatures, is a demonſtration that theſe effects were not altogether unknown; yet they were conſidered ſo immaterial as not to require the mention of temperature in the act of parliament. This omiſſion has added conſiderably to the irregularities of the various hydrometers ſince in uſe, as by it the legal ſtandard for proof is rendered very uncertain, and will, by the ordinary change of temperature, vary from five to ſix per cent.

I here beg leave to quote an obſervation of ſir Charles Blagden, from the Proceedings of the Royal Society in 1790, in his Report on the beſt Method of proportionating the Exciſe upon Spirituous Liquors made by Deſire of Government:

"By the act of 2d George III. it is ordered, that the gallon of brandy or ſpirits, of the ſtrength of one to ſix under proof, ſhall be taken and reckoned at ſeven pounds thirteen ounces (which is underſtood by the trade to mean 55 of heat). Hence taking the weight of a gallon of water at the ſame heat to be 8 lb. 5 oz. and 66 parts, the ſpecific gravity of this diluted ſpirit will be found 9335 at 60: this ſpecific gravity indicates a mixture of 107 grains of water with 100 grains of pure ſpirit; whence, by a computation founded on the tables in this report, the ſpecific gravity of proof ſpirit will come out 916: but the rules of correction belonging to Dicas and Quin's hydrometer give the ſpecific gravity of proof ſpirits about 922, at 55, equivalent to 920, at 60. The former, 916, correſponds to a mixture of 100 parts of ſpirit with 62 by meaſure, or 75 by weight of water; and the latter, 920, to a mixture of 100 parts of ſpirit, and 66 by mea-

recours à la méthode de Fahrenheit: j'ai vu depuis, qu'elle avoit eté miſe en uſage par M. Briſſon. J'entends par cette méthode celle de l'aréomètre *inventé* par Fahrenheit. et ſuivi par Clarke et Deſaguliers." He afterwards deſcribes the inſtrument, and condemns it for its complications, and being improperly graduated: from this it would appear that this inſtrument was invented by Fahrenheit, and not by Clarke.

5 ſure,

ſure, or 80 by weight of water. The difference is conſiderable, but the firſt is undoubtedly moſt conformable to the exiſting acts of parliament: if, therefore, it be thought right to preſerve the term *proof ſpirit* in our exciſe laws, it may be underſtood to mean ſpirit whoſe ſpecific gravity is 916, and which is compoſed of 100 parts of rectified ſpirit at 825, and 62 parts of water, by meaſure, or 75 by weight; the whole at 60 degrees of heat."

From this extract it appears there are no leſs than three imperfections in this manner of defining proof ſpirits. Firſt, the ſpirit defined is not proof, but another ſpirit, one *to* ſix, or one *in* ſeven, under proof, requiring a ſubſequent proceſs to make proof: ſecondly, the difficulty of procuring an exact gallon meaſure.

The late ingenious Mr. Ramſden, in a publication on this ſubject, printed in 1792, ſpeaking of the ſtandard of proof, ſays: "Hydrometer-makers differ on this point $7\frac{1}{2}$ per cent.; and government, to avoid diſputes, have been under the neceſſity of paſſing an act to conſtitute Clarke's hydrometer (for a ſhort time) the only legal one, though it is, in all probability, as vague as any of the others, particularly in ſpirits conſiderably higher than proof. An obſtacle to aſcertaining this term (ſays he) ariſes from the difficulty of obtaining *practically* the exact capacity of our gallon meaſure: it is, indeed, ſtated to contain 231 cubic inches; yet, notwithſtanding the great pains taken by a committee of the houſe of commons, about the year 1758, for that purpoſe, aſſiſted by ſeveral ingenious mechanics, this point was left undetermined. The method they uſed was making *hollow cubes* of different dimenſions, from one inch upwards, which were executed with great care by the late Mr. J. Bird, and are now in the repoſitory of the houſe of commons: but whoever conſiders the difficulty of making an exact cube, and that of aſcertaining the inſide calibre with preciſion, muſt be ſenſible that no great reliance can be had on the exactneſs of a gallon meaſure obtained by this method."

Thirdly, that no temperature being mentioned, the ſtrength is doubtful; and though ſir Charles, in this part of his Report (which has not, I believe, been contradicted), ſays the trade conſiders the temperature to be 55, and that proof ſpirit ſhould be as he ſtates, by the unerring teſt of the ſpecific gravity 916, at 60, (and which would be 918, at 55;) yet the ſpecific gravity of proof ſpirit, by Clarke's hydrometer, is 924, at 55 of temperature.

From this it appears, that even Quin's and Dicas's ſtandards of proof are erroneous to an extent of three per cent.; and

and that Clarke's is nearly four and a half different from the ftrength prefcribed by the ftatute: this is fuppofing the temperature to be what fir Charles fays it is confidered by the trade.

In Ireland the ftandard of proof is ftill more uncertain, no definition of it whatever appearing on the ftatute, but refting folely on the practice which prevailed in England prior to the 2d of his prefent majefty, viz. mixing water with an equal portion of rectified fpirits of wine, as it is called, no fpecific gravity of the fpirit mentioned, and the fpirit, called rectified fpirit of wine, differing materially in point of ftrength: neither has the temperature been attended to, the hydrometer there having no thermometer attached to it: the ftandard of proof has confequently become juft what the maker of the Irifh hydrometer pleafed: the generally received opinion, however, fuppofes it to be nine per cent. over Englifh hydrometer proof.

Two material imperfections appear in Clarke's hydrometer, exclufive of its complexity; namely, that neither variations of temperature, nor the gradations of ftrengths, have been fufficiently attended to: with refpect to the former of thefe, the fame weather-weight (as it is called by the trade) is ufed, though the temperature fhould vary four or five degrees.

The inventor, forefeeing that this was liable to weighty objections, conceives he has guarded againft it by the direction he gives in a N. B.: but this N. B., fo far from removing doubts, only ferves to increafe them; the words *about* and *near* leaving room for much to be gueffed at, and much more to be apprehended, where the important points it alludes to are fo loofely and indiftinctly defined.

May I be permitted in this place to explain the confequences of this mode of including four or five degrees of temperature to be indicated by the fame weight, by ftating a cafe that has frequently occurred?—A merchant in Ireland fhips for London a quantity of fpirit, and previous to its fhipment examines the ftrength by Clarke's hydrometer: he adjufts the ftrength to be fomewhat lefs than 10 per cent. (fuppofe $9\frac{1}{2}$) over hydrometer proof, the ftrength allowed to be importable without an augmentation duty: this fpirit is per fpecific gravity 910, temperature 55. Suppofe it to be arrived in London, but the temperature is then 60; notwithftanding this increafe of temperature (of 5 degrees) the fame weather-weight continues to be ufed in trying the ftrength in England which was applied in Ireland: by this increafe of temperature, the fpecific gravity being diminifhed to $907\frac{3}{4}$ths, when it comes to be proved in London, by the fame hydrometer,

meter, it then appears to be full one and a half per cent. ftronger than when it was fhipped, and will now be found to be 11 per cent. over proof. Should this fpirit be a foreign one, viz. brandy or geneva, it muft pay the entire augmentation duty of 11 per cent.; whereas, if the temperature was fufficiently difcriminated, it fhould have paid no augmentation duty whatever.

That this cafe is not merely a fuppofition, is, I believe, well known to feveral refpectable merchants in London, to whom confignments of foreign fpirits have been made from Ireland, and who, in feveral inftances, have been obliged to pay this augmentation duty of 11 per cent. Here, therefore, the inftrument proves its own errors; nor can additional weights remedy it.

The principle on which it is conftructed fuppofes that the ratio of expanfion by heat is the fame in ftrong as in weak fpirits; the fame weight for temperature is therefore applied to both: this is totally erroneous, and is demonftrable thus:

Suppofe a weak fpirit to be tried, the fpecific gravity of which, at the temperature of 35, is 960·48, let the temperature be increafed to 70, the fpecific gravity will be 948·13; the diminution, confequently, is 12·35.

Suppofe next, the fpirit under trial to be a ftrong one, and is per fpecific gravity at 35, 843·49; increafe the temperature, as in the firft, to 70, the fpecific gravity will be only 827·01: diminution in this fpirit 16·48; *difference* in the ratio of expanfion 4·13; this difference making full three per cent. by the hydrometer, and thus demonftrating a radical defect in the inftrument which *cannot be cured by additional weights.*

The fpirituous liquors of commerce being mixtures of pure fpirit and water, and the value of this, and the duty to be paid on it, depending on the quantities of the former which are contained in the mixture, it becomes neceffary to afcertain the proportion in which it enters into every fuch mixture.

The eafieft and moft expeditious mode of afcertaining this is by an hydrometer, which acts on the following well-known principles of hydroftatics.

A folid body defcends in a liquid, becaufe it is heavier than an equal bulk of the liquid: and it defcends with a force or weight equal to the excefs of its own weight, over the weight of an equal bulk of the liquid; or, if it be lighter than an equal bulk of the liquid, it afcends with a force proportioned to the difference of weights; but if it be of the fame weight as an equal bulk of the liquid, it will remain where it is placed.

Hence

Hence it is evident that every variation of gravity in the liquid will affect the indication on the hydrometer.

This gravity is known by the term *specific gravity*; and as the specific gravity of liquids is not absolute, but relative, this can only be determined by comparison: the first operation, therefore, consists in getting one whose absolute weight is known, in order to serve as a fixed point, and to determine, in its turn, a comparison of the density of the liquid. Pure water having always been considered the best standard for this purpose, the term specific gravity is most readily defined, by saying, that it is as the weight of the liquid is comparatively with pure water: for instance, if a phial, which holds precisely 1000 grains of water, holds only 922 grains of a spirituous liquor, the specific gravity of this spirit is said to be 922.

But as spirits expand by heat, and contract by cold, this specific gravity varies according to the degree of the heat of the liquor, which is called its temperature: therefore it is necessary first to ascertain what that may be, and it is done very accurately by the thermometer. And in the experiment mentioned, supposing the temperature to have been 55, if the spirit be heated to 70, the specific gravity will be diminished to $915\frac{1}{2}$; and, if afterwards it be cooled down to 35 degrees of temperature, it will be found to have increased to $930\frac{1}{4}$.

This is a very convenient manner of trying and expressing what the specific gravity of the liquor may be; and as I shall hereafter have occasion to use the term frequently, I hope I shall be excused for explaining it in this place.

All the variations of the specific gravity of spirituous liquors, and the causes of them, may be comprised under the following heads, viz.

1st, Those arising from heat and cold: 2dly, A difference in the proportions of the spirit and water: and, 3dly, The effects of penetration (or, as it is called, concentration), which takes place on the mixture; all of which, being so clearly defined by sir Charles Blagden, in his Report on this subject, in the second part of the 80th volume of the Transactions of the Royal Society, I shall beg leave to give it in his words, and lament that the proposed limits of this work will not permit me to give the entire Report, every paragraph of which I conceive to be important, and demonstrates the difficulties with which this subject is enveloped, and very clearly points out the way to remove them.

" Though (says sir Charles) various indications of the strengths

ſtrengths of ſpirituous liquors have been deviſed, applicable in a groſs manner to a general uſe, it is well known that no method admits of real accuracy but that of the ſpecific gravity. The weights of an equal bulk of water and pure ſpirit differ from one another by at leaſt a ſixth part of the weight of the former; whence it is obvious, that when thoſe two fluids are mixed together, the compound muſt have ſome intermediate ſpecific gravity, approaching nearer to that of water or pure ſpirit, as the former or the latter is the more predominant ingredient.

" Were it not for a certain effect attending the mixture of water and ſpirit, which has been called their mutual penetration, the ſpecific gravity of theſe compoſitions, in a given degree of heat, would be ſimply in the arithmetical proportions of the quantity of each of the fluids entering into them.

" But whenever different ſubſtances, which have a ſtrong tendency to unite together, are mixed, the reſulting compound is found to occupy leſs ſpace than the ſubſtances forming it held in their ſeparate ſtate; wherefore the ſpecific gravity of ſuch compounds is always greater than would be given by a ſimple calculation from the volume of their ingredients. Though it be a general fact, that ſuch a decreaſe of bulk takes places on the mixture of ſubſtances which have a chemical attraction for each other; yet the quantity of this diminution is different in them all, and, under our preſent ignorance of the intimate compoſition of bodies, can be determined by experiment only. To aſcertain, therefore, the quantity and law of the condenſation reſulting from this mutual penetration of water and ſpirit, was the firſt object to which the following experiments were directed.

" All bodies, in general, expand by heat: but the quantity of this expanſion, as well as the law of its progreſſion, are probably not the ſame in any two ſubſtances. In water and ſpirit they are remarkably different. The whole expanſion of pure ſpirit, from 30° to 100° of Fahrenheit's thermometer, is not leſs than 1-25th of its whole bulk at 30°; whereas that of water, in the ſame interval, is only 1-145th of its bulk. The laws of their expanſion are ſtill more different than the quantities. If the expanſion of quickſilver be, as uſual, taken from the ſtandard (our thermometers being conſtructed with that fluid), the expanſion of ſpirit is, indeed, progreſſively increaſing with reſpect to that ſtandard, but not much ſo within the above-mentioned interval; whilſt water kept from freezing to 30°, which may eaſily be done, will abſolutely contract as it is heated, for ten or more degrees,

degrees, that is, to 40° or 42° of the thermometer, and will then begin to expand as its heat is augmented, at firſt ſlowly, and afterwards gradually more rapidly, ſo as to obſerve upon the whole a very increaſing progreſſion.

"Now mixtures of theſe two ſubſtances will, as may be ſuppoſed, approach to the leſs or the greater of thoſe progreſſions, according as they are compounded of more ſpirit or more water; whilſt their total expanſion will be greater according as more ſpirit enters into their compoſition: but the exact quantity of the expanſion, as well as the law of the progreſſion, in all of them, can be determined only by trials. Theſe were therefore the two other principal objects to be aſcertained by experiment." Sir Charles then proceeds to deſcribe thoſe various experiments, and which are too long to admit an inſertion of them here; but from a peruſal it will be perceived they were conducted with a degree of patient inquiry, minuteneſs of attention, and accuracy of inveſtigation, ſeldom to be met with, and which, with the calculations grounded on them by Mr. Gilpin, clerk of the ſociety, and publiſhed in the Tranſactions for 1794, have removed thoſe obſcurities with which the ſubject had heretofore been enveloped.

Theſe celebrated experiments, and the table deduced from them, have been minutely examined by ſeveral of the ableſt philoſophers in France and various other parts of the continent, and they are allowed to be what Mr. Nicholſon (who has alſo minutely examined them), in his Chemical Dictionary, ſays, may be conſidered as fundamental reſults; and it is ſomewhat remarkable that, ſince their publication in 1794, no perſon has hitherto availed himſelf of the important information they contain, as a foundation for putting a period to thoſe irregularities and uncertainties which have been ſo long and ſo univerſally complained of.

That hydrometers ſhould be complicated in their ſtructures, and erroneous in their indications, previous to this period, is not to be wondered at.

The ſpecific gravity of the ſpirit, which is the foundation of the hydrometer indication, was but little attended to; and thoſe variations which take place in the ſpecific gravity, through the ſeveral cauſes above mentioned, having never before that period been preciſely aſcertained, hydrometers, inſtead of being graduated by this unerring teſt, have been graduated by compariſon with another inſtrument, called a ſtandard, but no means have been pointed out to prove that this ſtandard was correct.

Theſe tables of Mr. Gilpin, however, furniſh ſuch elemen-

 tary

tary information as has enabled me, by the addition of four columns, to remove all doubts and uncertainties on the subject, by demonſtrating, from the ſpecific gravity of the ſpirituous liquor, what the hydrometer indications ſhould be of every gradation of ſtrength.

In the Report, which accompanies theſe tables, ſir Charles Blagden makes an obſervation which firſt ſuggeſted to me the utility of theſe additional columns.

" It may very probably be thought right (ſays he), for the future uſe of the revenue, to compute another ſet of tables, in which the degrees of heat ſtanding at the head of each table, the firſt column of it ſhall be even numbers of ſpecific gravity. This would be proper for looking out at once the quantities of ſpirit and water in a mixture from its heat and ſpecific gravity."

Sir Charles, by this obſervation, alludes not to the means of obtaining the hydrometer indication, but to an opinion he had given in his firſt Report, in 1790, that the ſimpleſt and the moſt equitable way of levying the duty on ſpirituous liquors would be to conſider pure ſpirit as the true and only exciſeable matter, inſtead of the relation to the ſtandard of proof, and for calculating which one column of the table is a decimal multiplier, to aſcertain the proportion of this in any given quantity of a ſpirituous liquor; an idea which certainly is ingenious, and, at firſt view, appears to have the recommendation of ſimplicity: but as every diſcrimination of ſtrength would require an operation of figures, fractions would unavoidably occur, from which, and the delay and danger of errors in theſe operations, this mode, I conceived, had been conſidered practically inconvenient, and therefore was not adopted.

The relation to the ſtandard of proof having been long recognized by the different ſtatutes, and in commerce, I thought it probable it would not be laid aſide; nor was it, as I conceived, neceſſary to do ſo when a means preſented itſelf of rendering this relation to proof equally correct as that which he pointed out: and the new ſet of tables, which at firſt I apprehended he was about to deſcribe as uſeful for the revenue, were thoſe which would deduce the hydrometer indication of ſtrength from the ſpecific gravity of the ſpirit at a given temperature. A table for this purpoſe would, I conceived, be importantly uſeful on ſeveral accounts: 1ſt, it would afford a mode of graduating an hydrometer on a certain principle; and, 2dly, that as it furniſhed a ſtandard for every gradation of ſtrength, errors could be diſcovered in thoſe inſtruments that have been graduated by the deluſive mode of

 compariſon,

compariſon, many of whoſe diſcriminations of ſtrength being, as I had reaſon to believe, merely conjectural.

Before I proceed to explain Mr. Gilpin's tables, and the columns added to them, it becomes neceſſary to define what is meant by the term *pure ſpirit,* and to inquire whether the ſpirit which ſir Charles deſcribes can with propriety be called ſuch.

" The firſt ſtep (ſays he, in the Report made on this ſubject in 1790) towards a right performance of the experiments, was to procure the two ſubſtances with which they were to be made, as pure as poſſible. Diſtilled water is in all caſes ſo nearly alike, that no difficulty occurred with regard to it; but the ſpecific gravity of pure ſpirit, or alcohol, has been given ſo very differently by the authors who have treated of it, that a particular ſet of experiments appeared neceſſary for determining to what degree of ſtrength rectified ſpirit could conveniently be brought. The perſon engaged to make theſe experiments was Dr. Dollfuſs, an ingenious Swiſs gentleman, then in London, who had diſtinguiſhed himſelf by ſeveral publications on chemical ſubjects. Dr. Dollfuſs, having been furniſhed by government with ſpirit for the purpoſe, rectified it, by repeated and ſlow diſtillations, till its ſpecific gravity became ſtationary in this manner of operating: he then added dry cauſtic alkali to it, let it ſtand for a few days, poured off the liquor, and diſtilled it with a ſmall addition of burnt alum, placing the receiver in ice. By this method he obtained a ſpirit whoſe ſpecific gravity was 8188, at 60 of heat. Perceiving, however, that he could not conveniently get the quantity of ſpirit he wanted lighter than 82527, at 60, he fixed upon that ſtrength as a ſtandard.

Several highly reſpectable authorities might be produced to prove this ſpecific gravity to be a proper ſtandard for *pure ſpirit.*

[To be continued.]

XXVI. *A ſhort Account of the Mammoth. By Mr.* Rembrandt Peale *.

THE mammoth is ſo called from the Ruſſian name, ſuppoſed to have been derived from the Hebrew *Behemoth,* Job, chap. xl. It is properly continued, both words being expreſſive of a large and extraordinary animal.

For a number of years paſt many large and extraordinary

* Communicated by the Author.

bones

bones and teeth have been diſcovered both in Siberia and America, which at firſt were generally attributed to the elephant *, except ſome very large teeth of the carnivorous kind totally different from thoſe of any animal known.

In Siberia they were attributed to the mammoth, whoſe fabulous exiſtence they ſuppoſed to be under ground, and of which Iſbrand Ides pretends to give a deſcription. In North America theſe large bones and carnivorous grinders have been found in great abundance on the Ohio and its tributary ſtreams, waſhed from their banks, or diſcovered by digging in ſalt moraſſes in the neighbourhood of Cincinatti; where they are found intermixed with the bones of buffaloes and deer, which a tradition of the Indians ſtates to have been deſtroyed by a herd of theſe animals which came upon them from the north. This event happened, the Indians believe, as a puniſhment for their ſins; but they ſay the good ſpirit at length interpoſed to ſave them, and, ſeating himſelf on a neighbouring rock, where they ſhow you the print of his ſeat and of one foot, hurled his thunderbolts among them. All were killed except one male, who, preſenting his forehead to the ſhafts, ſhook them off, until, at length wounded, he ſprung over the Wabaſh, the Illenois, and the Great Lake, where he ſtill lives.

Theſe bones were forwarded with great eagerneſs to all parts of Europe, and depoſited in muſeums, where they attracted the curioſity of all naturaliſts, whoſe conjectures and theories on them were very various, until Dr. Hunter, by a more accurate compariſon between them and the bones of other animals, determined that they muſt have belonged to a large non-deſcript animal of the carnivorous kind, ſomewhat reſembling the hippopotamus and the elephant, yet eſſentially different from both.

The ſubject is now completely elucidated. Not long ſince ſome farmers in the State of New York, in America, digging marle from their moraſſes in the neighbourhod of New-Windſor, accidentally diſcovered ſeveral of theſe bones, which were preſerved by phyſicians in the neighbourhood. In the autumn of 1801, my father Charles W. Peale and myſelf, having obtained poſſeſſion of theſe bones, perſevered for nearly three months, at the expenſe of much time, labour, and money, in a ſearch for the remainder of the animal; and were fortu-

* Naturaliſts were led to this idea in conſequence of finding, in a few inſtances in America, but frequently in Siberia, ſome large graminivorous teeth, which probably belonged to an animal of the elephant kind, though certainly of different ſpecies from any known: theſe teeth are remarkable for ſize, and in the number of lamellated veins of enamel which pervade them.

nate enough to obtain two ſkeletons, found in two diſtinct ſituations, and unmixed with bones of any other individual whatever: one of theſe is preſerved in the Muſeum at Philadelphia, and the other is now exhibiting in the Old Academy-room, Pall-Mall, previouſly to its being taken to Paris.

The ſkeleton of the mammoth bears ſome general reſemblance to that of the elephant, yet on examination even the general figure is found to be conſiderably different; principally in the effect of the tuſks, ſtructure of the head, prominence and pointedneſs of the back over the ſhoulders, its great deſcent thence to the hips, together with the comparative ſmallneſs of the body and the neceſſarily detached effect of the hind-legs—proofs of greater activity than in the elephant. On a cloſer examination, the characteriſtic features are greatly multiplied; and with reſpect to the hind-legs, the idea of activity is confirmed from the ſtructure of the thigh-bones, which are extremely broad and flat, and well adapted for great exertions of ſtrength, beyond that of the elephant, whoſe thigh-bones are not flat, but round. This effect of ſtrength likewiſe prevails in the ribs, which are of a very unuſual ſtructure, being bent edgewiſe and having their greateſt thickneſs at top, gradually becoming ſmaller towards their junction with the cartilage; whereas in the elephant they are bent flatwiſe, like thoſe of the ox, and are narrow at top and broad at the lower ends. This peculiarity in the ribs of the mammoth is worthy of particular notice, not only on account of the unuſual poſition of ſtrength, but becauſe, from their diſtance between each other, they ſhow the animal to have had conſiderable flexibility in its body; to which the breadth and proximity in the ribs of the elephant, as well as the ox, are a certain impediment. Beſides, as I obſerved before, the body is comparatively ſmaller, in conſequence of the ſmall length of the ribs.

The ſpines of the back over the ſhoulders are of an unuſual magnitude, which gives the appearance of a hump, like the biſon, and are calculated to give power and motion to the head. Thoſe in the elephant are not ſo large over the ſhoulders, but much more ſo all the way to the ſacrum: conſequently his back is more arched. The proportionate length of the proceſſes from the ſpine of the ſcapula differs eſſentially from all other animals. And, independently of any other variation in form, all the bones, of the limbs in particular, are aſtoniſhingly thick and ſtrong.

We now come to the head, where the moſt ſtriking features of this animal are to be found; and ſince between the correſponding parts of all animals there is a general analogy, it is the

the province of comparative anatomy not only to trace out the points of diſtinction, but, ſince they originate from certain fixed principles, in the diſcrimination of variations, to confirm their propriety by an examination of the principles on which they are founded.

Although it is ſufficiently evident to thoſe who are accuſtomed to this kind of inveſtigation, from the obſervation of a few facts, that this animal muſt have been carnivorous; yet to others it is neceſſary to introduce every proof and concluſive evidence. Many perſons, from a falſe impreſſion, believe that teeth are determined to be carnivorous merely from their having a rugged ſurface: with this opinion they very properly aſk, "May not the vegetable food be of a coarſer quality?" It is true that the ſurface is rougheſt on thoſe graminivorous teeth which are employed in the maſtication of the coarſeſt vegetable ſubſtances, not only becauſe ſuch roughneſs is requiſite, but becauſe the teeth are rendered ſo from the quality of the food, the bony interſtices wearing down more eaſily than the ridges of enamel, which operate as the roughneſs in a mill-ſtone. It is not therefore from this ſpecies of roughneſs that we preſume on ſo important a determination: the roughneſs exiſting on the ſurface of carnivorous teeth is of another nature, much more ſtrongly marked, and far from being rendered ſo by uſage: the more they are uſed, the more even do they become. The tooth of a graminivorous animal is compoſed of *alternate veins* of enamel and bone, which thus pervade the whole maſs: thoſe of carnivorous animals are covered with a ſhell or cruſt of enamel, which is merely external, and exiſts as well in the cavities as on the ridges; which is not the caſe with other teeth. This enamel is required in the cavities, becauſe the teeth interlock with each other, the prominences ſtriking into the cavities.

An uniform compoſition of tooth, as it reſpects the intermixture of enamel and bone, is obſerved to prevail in thoſe of the elephant, horſe, ox, &c. principally differing from each other in the *figure* which thoſe veins of enamel aſſume, and by which alone they may be diſcriminated among themſelves. On the other hand, carnivorous teeth, incruſted with enamel as far as the gums, yet vary in the form and number of their protuberances, ſo as generally to deſignate their ſpecies: yet among them there is a very proper diſtinction to be obſerved, which is, that thoſe carnivorous animals, the form of whoſe teeth and the attachment of whoſe jaws allow them the ſide or grinding motion, are always of the mixt kind. Man, the monkey, hog, &c. are carnivorous ani-

 mals,

mals, becaufe their teeth are incrufted with enamel, and becaufe they do eat flefh; yet they are adapted for other food, by the rotatory motion of their jaws and the form of their teeth: this rotatory motion does not exift in the jaws of thofe animals which live entirely upon flefh; for they are attached by an oblong head or procefs inferted into a tranfverfe groove, and confequently have no other motion than up and down. In graminivorous animals the under jaw is attached by means of a confiderably round head (condyloid procefs) to a prominence or flat furface, fo that they *rotate*; and, to favour this motion, the coronoid procefs is generally thicker and not fo long as the condyloid; whereas in carnivorous animals the coronoid procefs is extremely flat and long, being never acted on except lengthwife.

But it muft not even be fuppofed that an animal may be of the mixt kind, unlefs we obferve a capacity for maftication; without which we muft declare it exclufively carnivorous.

Some object to the carnivorous nature of the mammoth from its not having cutting or canine teeth. To this it may be replied, that if we form our rule of judgment, as to what conftitutes a graminivorous animal, from the conftruction of an ox's jaw, the elephant would certainly be excluded, becaufe it has not *incifores* at leaft in the lower jaw: the fact is, that all carnivorous as well as graminivorous animals differ among themfelves with refpect to the number and fituation of their teeth; and hence they afforded to the fagacious and celebrated Linnæus the moft infallible method of claffification, which has fince been adopted, either wholly or partially, by all naturalifts. The probofcis of the elephant anfwers the purpofe of *incifores*: he therefore requires no others than grinders, which entirely fill his jaws: hence he is completely graminivorous. And although the mammoth is deficient in cutting teeth, and has no other canine teeth than his enormous tufks, the deficiencies of which may have been fupplied by a pair of large and powerful lips, indicated by the uncommon finuofity on the front of the lower jaw; yet I am decidedly of opinion, fince it cannot be contradicted by a fingle proof or fact, that the mammoth was exclufively carnivorous; by which I mean, that he made no ufe of vegetable food, but either lived entirely on flefh or fifh; and not improbably upon fhell-fifh, if, as there are many reafons to fuppofe, he was of an amphibious nature. I therefore only require affent to thefe facts: 1ft, The teeth are certainly of the carnivorous kind: 2dly, They are not of the mixt kind, becaufe they have not the leaft rotatory motion,

and

and ſo completely lock together: 3dly, Since, therefore, they are not graminivorous, ſince they cannot be of the mixt kind, from a defect in motion, they muſt be excluſively and poſitively carnivorous.

Independently of the teeth, the under jaw of the mammoth differs moſt eſſentially from that of the elephant, which in its outline is ſemi-circular, from the condyle to the chin; whereas in the mammoth the outline is diſtinctly angular, and is much greater in the length than it is in the height, which is the reverſe in the elephant: beſides ſeveral other ſtriking diſtinctions in both jaws.

When the ſkeleton was firſt erected, I was much at a loſs how to diſpoſe of the tuſks; their ſockets ſhowed that they grew out forwards, but did not indicate whether they were curved up or down. I choſe, therefore, firſt to turn them upwards, not becauſe they produced the ſame effect as in the elephant, for it is evident they could not in any poſition, owing to two circumſtances. In the elephant, taking the level of the teeth for a horizontal baſe line, the condyle of the neck is at right angles with it; and the perpendicular, one third longer than the baſe line: hence they are uſeful on every occaſion, the tuſks themſelves being nearly ſtraight, and pointing downwards; whereas in the mammoth, taking the level of the teeth for a baſe line, the condyle of the neck is ſituated but a few inches above it: conſequently the ſockets for the tuſks and the condyle of the neck are in a horizontal direction: this circumſtance, together with the extraordinary curve of the tuſks, would raiſe the points in the air, directed in ſome degree backward over the head, twelve feet from the ground, and never could have been brought lower than ſix or ſeven feet from it. This poſition was evidently abſurd: I therefore reſolved on reverſing them; in which poſition, in conſequence of their twiſt or double curve, they appear infinitely more ſerviceable.

Six miles from the ſpot where this ſkeleton was diſcovered we found two entire tuſks, in form exactly like thoſe in the ſkeleton, but very much worn at the extremities (the point of one I have with me), and worn in ſo peculiar a manner, conſidering their form, as could not have happened in an elevated poſition; unleſs on the abſurd ſuppoſition, that the animal amuſed himſelf with wearing and rendering them blunt, by rubbing them againſt high and perpendicular rocks: this in a ſtate of nature can never be ſuppoſed, whatever habits may be acquired when in a narrow confinement. There can be no doubt, then, of their having been *uſed* againſt the ground, and not improbably in tearing up

L 4 ſhell-

ſhell-fiſh, if, as we have many reaſons to ſuppoſe, he was of an amphibious nature: for this ſpecies of food his teeth ſeem admirably adapted. All animals of ſimilar habits have ſimilar teeth: this animal has teeth unlike any other with which we are acquainted: there is much reaſon, therefore, in ſuppoſing his food to have been different; eſpecially when we conſider the thickneſs of enamel which covers the teeth, the peculiar manner in which they are worn, and the ſmall opening for the throat. But, whether amphibious or not, in the inverted poſition of the tuſks he could have torn an animal to pieces held beneath his foot, and could have ſtruck down an animal of common ſize, without having his ſight obſtructed, as it certainly would have been in the other poſition.

The tuſks themſelves are compoſed of two very diſtinct ſubſtances: the internal bony or ivory part, which we find in the greateſt ſtate of decay; and a thick, diſtinct coating, doubtleſs having undergone ſome decay, yet at preſent abſolutely heavier and harder than the freſheſt ivory. No part of the ſkeleton is petrified, but all in their preſent ſtate of preſervation from having been ſurrounded by a calcareous ſoil, compoſed principally of decayed ſhells, and covered with water even in the drieſt ſeaſons.

How long ſince theſe animals have exiſted, we ſhall perhaps ever remain in ignorance; as no judgment can be formed from the quantity of vegetable ſoil which has accumulated over their bones. Certain we are, that they exiſted in great abundance, from the number of their remains which are found in America: we are likewiſe ſure that they muſt have been deſtroyed by ſome ſudden and powerful cauſe; and nothing appears more probable than one of thoſe deluges or ſudden irruptions of the ſea, which have left their traces in every part of the globe, and which are in amazing abundance on the very ſpot where theſe bones are found: they conſiſt of petrifactions of ſea productions, ſhells, corals, &c. It is extremely probable that, whenever and by whatever means the extirpation of this tremendous race of animals was effected, the ſame cauſe muſt have operated in the deſtruction of all thoſe inhabitants from whom we might have received ſome ſatisfactory account of them.

Dimenſions of the Skeleton.

	Ft.	In.
Height over the ſhoulders - - -	11	0
Ditto over the hips - - -	9	0
Length from the chin to the rump - -	15	0

From

	Ft.	In.
From the point of the tuſks to the end of the tail, following the curve - -	31	0
Length in a ſtraight line - - -	17	0
Width of the hips and body - -	5	8
Length of the under jaw - - -	2	10
Weight of the ſame - 63½ pounds		
Width of the head - - -	3	2
Length of the thigh-bone - - -	3	7
Smalleſt circumference of the ſame - -	1	6
Length of the tibia - - -	2	0
Length of the humerus, or large bone of the fore-leg - - - -	2	10
Largeſt circumference of the ſame - -	3	2½
Smalleſt ditto ditto - - -	1	5
Length of the radius - - -	2	5½
Circumference round the elbow - -	3	8
Length of the ſcapula, or ſhoulder-blade -	3	1
Length of the longeſt vertebra, or back-bone	2	3
Longeſt rib, without cartilage - -	4	7
Length of the firſt rib - - -	2	0
Ditto of the breaſt-bone - - -	4	0
Length of the tuſks, defences, or horns -	10	7
Circumference of one tooth or grinder -	1	6½
Weight of the ſame, 4 pounds 10 ounces		
The whole ſkeleton weighs about 1000 pounds.		

XXVII. *New Theory of the Conſtitution of mixed Gaſes elucidated.* *By* J. Dalton, *Eſq.**

In an eſſay, publiſhed in the Memoirs of the Literary and Philoſophical Society of Mancheſter, vol. v. part 2, I gave a new theory of the conſtitution of mixed gaſes, and particularly of the atmoſphere, and endeavoured to illuſtrate my meaning by a plate, &c. Notwithſtanding this, I am informed by ſome of my chemical friends that they do not clearly underſtand the hypotheſis itſelf, and conſequently are not able to judge of its merits or defects: and a late writer (Dr. Thomſon) in his Syſtem of Chemiſtry, vol. iii. p. 270, ſpeaking of the uniform diffuſion of the different gaſes of the atmoſphere, makes the following obſervation:—"Even Mr. Dalton's ingenious ſuppoſition, that they neither attract nor repel each other, would not account for this equal diſtribution; for, undoubtedly on that ſuppoſition they would arrange

* Communicated by the Author.

themſelves

themſelves according to their ſpecific gravity." Now, as I am perſuaded that no one acquainted with the principles of mechanical philoſophy could have written the above if he had underſtood my hypotheſis, it ſeems to call from me a further explanation. I propoſe therefore, 1ſt, To ſtate, in as clear a point of view as the ſubject will admit, the principles which I aſſume: 2d, To ſhow that the conſequences which I have deduced from them are legitimate; and, particularly, that mixed elaſtic fluids ought *not* to arrange themſelves according to their ſpecific gravity: and, 3d, To demonſtrate that the ſuppoſition of the gaſes conſtituting the atmoſphere being held in a ſtate of equal diffuſion by chemical affinity, is not only inconſiſtent with the phænomena, but is completely abſurd.

I. *Principles aſſumed.*

1. I take for granted, that the particles of ſimple [unmixed] elaſtic fluids repel one another with forces inverſely as the diſtance of their centres, the temperature being given. This is a mathematical deduction from the allowed fact, that the ſpace occupied by any gas is inverſely as the compreſſing force. (See Newton's *Principia*, b. ii. prop. 23.) The *abſolute* diſtances of the centres of ſuch particles muſt vary according to circumſtances, and cannot eaſily be determined; their *relative* diſtances in a liquid and aërial ſtate ſometimes may. Mr. Watt has ſhown that ſteam of 212°, and preſſure 28 inches, is 1800 times lighter than water; conſequently the diſtances of the particles of ſteam are to the diſtances of the ſaid particles in a liquid ſtate as 12 to 1, nearly, in that particular caſe. Vapour in the vacuum of an air-pump, at common temperature, will have its particles about four times the diſtance, or 48 to 1.

2. I ſuppoſe that in mixed elaſtic fluids the heterogeneous particles do not repel one another at all at ſuch diſtances as they repel thoſe of their own kind; but that ſuch particles, when brought into actual contact (to uſe the common language), reſiſt each other in all reſpects like inelaſtic bodies. This is the peculiarity of the hypotheſis, and what appears not to be generally underſtood. If I may explain by analogy, the moſt ſtriking will be found in magnetiſm. Two like poles of magnets repel one another with the ſame force, whether any other bodies intervene or not, and do not affect thoſe other bodies: in the ſame way I conceive two particles of any one gas repel one another with the ſame force, whether particles of other gaſes intervene or not, and do not affect thoſe other particles. A magnet is amenable to the common laws of

of motion in its collifion with other bodies, and when it is brought into feeming contact with them; fo is a particle of one gas when it is brought into feeming contact with a particle of another fpecies; and in this cafe the bodies may be faid to have a repulfive power: but this power is effentially different from the other, in that it extends to no definite diftance. Further, conceive a very fine capillary tube placed perpendicular to the horizon, into which let a number of correfpondent fmall magnetic wires, or particles, be inferted, with their poles of the fame denomination together, or, more ftrictly, as near as their repulfive power would admit, one particle above another, the air having intercourfe amongft them. Then, as the magnetic particles would not actually touch one another by reafon of their repulfion, they would *feem* to be fupported by the intervening air; whereas in reality they are fupported and kept at certain diftances entirely by the repulfion inherent in themfelves and their own gravitation: and thus, I conceive, particles of gas fupport thofe of their own kind above them, though, were they vifible, they might feem to reft upon others immediately under them; and the ground, or loweft folid or liquid furface, by fupporting the loweft particle of each kind, has the weight of the whole to fuftain. Thefe obfervations, together with a view of the plate above alluded to, muft, I think, be fufficient to fatisfy any one what the hypothefis is. And it may be proper to add, there is fomething much refembling polarity obfervable in the ultimate particles of bodies at the inftant of tranfition from the liquid to the folid ftate: witnefs the congelation of water.

II. *Confequences.*

It is plain from the above account that I conceive any one gas to be conftituted of perhaps *one* part folid matter, and *one thoufand* or more parts vacuity or pore, if it may be fo called; and that into this vacuity we may throw as many other gafes as we pleafe without materially difturbing the firft, provided we do not abfolutely fill the vacuity with folid matter (for fo I denominate common liquids or folids). Thus, we might have had a dozen gafes in our atmofphere inftead of three or four, all in the fame compafs, and each retaining the fame denfity it would have had alone. The heavier gas has no more tendency to raife the lighter than a quantity of fhot has to expel the air from its interftices. If therefore Dr. Thomfon, or any other, can fhow how one fluid, which is not difplaced nor any way acted on by another, fhould by its *reaction* caufe that other to move into a higher or lower ftation, then the mathematical world will be obliged to reconfider their

their doctrine of ſtatics. Till then I muſt take the negative of the propoſition, and conclude that elaſtic fluids of the greateſt and leaſt ſpecific gravity imaginable, on the ſuppoſition I hold, will alike take the loweſt and the higheſt ſtations, regardleſs of each other; or, in other words, they will arrange themſelves in the ſame order as if thrown into a complete vacuum. The great difficulty reſpecting the uniform diffuſion of the gaſes being removed, I think on my hypotheſis the other phænomena can require no explanation to any perſon converſant in pneumatics. I will take one inſtance: it may be aſked, How does ſulphuret of potaſh abſtract oxygenous gas out of any mixture; lime water, carbonic acid gas, &c. &c.? The anſwer is obvious: Exactly in the ſame way as if the gas in queſtion was the only one in the veſſel, and the operation going on in a cloſe veſſel.

III. *Gaſes held together by chemical Affinity abſurd.*

On this head it will be proper to premiſe certain facts:

1ſt, When two gaſes of different ſpecific gravity, ſuch as oxygenous and hydrogenous, are put into the ſame veſſel and agitated; then, after ſtanding ſome time, they ſtill continue uniformly mixed.

2. They occupy the ſame ſpace before and after mixture; that is, *one* meaſure of each put together occupy *two* meaſures, the temperature and preſſure being the ſame. Mr. Davy ſeems to think this principle not ſtrictly true in regard to a mixture of azotic and oxygenous gas; but the deviation from it, if any, is extremely ſmall.

3. The compound is ſubject to the ſame laws of rarefaction and condenſation as the ſimples.

There are but *three* ſuppoſitions we can make eſſentially different reſpecting the mutual action of heterogeneous particles of gas. 1ſt, When two gaſes are mixed, their particles may reciprocally *repel* one another, juſt as they act on their own kind in an unmixed ſtate: 2d, They may be neutral, or have neither attraction nor repulſion for each other: 3d, They may have a chemical affinity or *attraction* for each other. The advocates for the chemical adheſion of gaſes will agree with me in exploding the *firſt*, becauſe, where nothing but *repulſion* is manifeſt, we can aſcribe no effect to attraction: the *ſecond*, which is the one I adopt, is obviouſly inconſiſtent with their hypotheſis: and as for the *third*, I can conceive no other explanation than the following: 1ſt, Two or more heterogeneous particles may unite, and become a new centre for the caloric to adhere to; but in this caſe the gaſes are no

 longer

longer *two* but *one*, and oxygenous gas and hydrogenous will become aqueous vapour: this, therefore, would not be a cafe of two *gafes* held together by affinity. 2. Two gafes may feparately retain their caloric, and ftill be held by chemical affinity; that is, there may be an equilibrium between the powers of attraction and repulfion: but this is evidently inconfiftent with the third law of condenfation and rarefaction, obferved in fuch compounds.

Manchefter,
Nov. 20.

J. DALTON.

Note. I have lately read a paper to the Literary and Philofophical Society of Manchefter, in which I have fhown that the quantity of carbonic acid gas found in a given volume of atmofpheric air is not more than $\frac{1}{1000}$th part of the whole; and that the faid gas is held in water, not by chemical affinity, but merely by the preffure of the gas, abftractedly confidered, on the furface, forcing it into the pores of the water.

XXVIII. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

THIS learned body has recommenced its labours by beftowing on count Rumford the firft medal awarded from the fund provided by the count himfelf for difcoveries on the nature and properties of heat.

The Copley medal has been adjudged to Dr. Woolafton.

On the firft night of meeting, which was on the 11th of November, the Bakerian lecture was delivered by Dr. Woolafton. The fubject, horizontal refraction.

On the 18th was read a paper, by Mr. Chenevix, on the chemical properties of the humours of the eye; and one by Mr. Smithfon on calamines or ores of zinc.

On the 25th, a paper, by M. Aldini, on the galvo-electricity of hot-blooded as well as cold-blooded animals. The experiments detailed in this curious paper are fimilar to thofe of which we gave an account in our laft, and to fome detailed in a fubfequent page of our prefent number.

FRENCH NATIONAL INSTITUTE.

Account of the labours of the Clafs of the Mathematical and Phyfical Sciences during the laft quarter of the year 10. —The mathematical part by Lacroix fecretary.

ASTRO-

ASTRONOMY.

Calculation of Observations of two Occultations of the Spica Virginis by the Moon, which took place in the Year 9—Discovery of a new Comet—Observations of the Planet discovered by Dr. Olbers.

Occultations of the ftars by the moon are fo ufeful for improving geography, by determining the longitude, that they have been ranked among the moft important of the celeftial phænomena; and in this clafs thofe eafieft to be obferved, and which give the fureft refults, are occultations of ftars of the firft magnitude.

The moon, by the pofition of its orbit, can eclipfe only four; namely, Aldebaran, Regulus, Centares, and the Virgin's Spike; but the paffage of the latter behind the moon's difk rarely takes place. C. Lalande knows only four epochs in the fpace between 1623 and 1790; and the year 9 having exhibited two, he took care to unite and calculate the obfervations which reached him of this phænomenon.

For the firft occultation, which took place on the 30th of March, thefe obfervations are in number fixteen, of which the city of Paris alone furnifhed fix, carefully made by the moft diftinguifhed aftronomers. It was from an obfervation made by C. Ciccolini, at Florence, that Lalande determined the longitude of that city, which he publifhed fome time ago, expreffing his aftonifhment that the pofition of a city of fo much importance fhould have hitherto been fo inaccurately fixed.

The longitude of the moon, deduced from obfervations at the time of the conjunction of thefe two bodies, is lefs by 13″ than that given in the tables lately tranfmitted to the board of longitude by M. Burg.

Fourteen obfervations of the fecond occultation, which took place on the 24th of May, were examined and calculated with the fame care as the preceding. On this occafion there was an obfervation alfo at Florence, the refult of which gave 6″ more in time in the difference of meridians between that city and Paris, as deduced from the firft occultation.

The error of the tables of M. de Burg was,

In longitude	-	-	+ 4″
In latitude	-	-	+ 3

On the 1ft of September C. Mechain read in the fame fitting a notice on the new comet which he difcovered at the national obfervatory on the evening of the 28th of Auguft in Serpentarius. It was not vifible by the naked eye: it refembled two nebulous ftars which are in the fame conftellation a little below the equator, and from which it was diftant only fome degrees towards the fouth. The centre of the nebulofity

fity feemed a little more luminous than the reft; but no fenfible nucleus was diftinguifhed, nor any trace of a tail. After that period the light of the comet always decreafed, becaufe it was removing from the earth. Its apparent motion in declination, which was at firft 2½ degrees towards the north, in 24 hours, was not more the laft day than 30 minutes. The motion in right afcenfion amounted towards the end to no more than 17 minutes in 24 hours. The fucceffive decreafe of the light of the comet, and the brightnefs of the light of the moon, did not allow of its being obferved any longer. It traverfed the conftellations of Serpentarius and Hercules.

During the 36 days it was vifible he determined its pofition on 23 different days; and from his own obfervations he calculated the elements of its orbit as follows: they have no refemblance to thofe of any of the preceding comets:

Perihelion diftance 1·0942046; the mean diftance of the earth from the fun being fuppofed 1·0.

Paffage of the perihelion Sept. 9, 1802, at 20 h. 43½′ mean time at Paris.

Place of the perihelion in the orbit -	11s	2°	7¾′
Longitude of the afcending node -	10	10	16¾
Inclination of the orbit - -		57	0½
Motion—direct.			

This comet is the 94th with the elements of the orbits of which we are acquainted, and the thirteenth difcovered by C. Mechain. It was obferved on the 26th of Auguft, or two days before, by C. Pons of Marfeilles; but on thefe two days the fky at Paris was overcaft. Dr. Olbers difcovered it alfo at Bremen on the 2d of September. C. Meffier, our fellow-labourer, and C. Bouvard, adjunct of the board of longitude, obferved it with great affiduity after the appearance of it had been announced by C. Mechain.

We fhall give here only four pofitions determined by C. Mechain; the firft, the laft, and the two intermediate ones: all the reft will be publifhed in detail in the next volume of our memoirs.

Dates.	Mean Time at Paris.	Apparent right Afcenfion.	Apparent Declination.
Aug. 28, 1802	9h 44′ 30″	249° 19′ 68″	6° 8′ 52″ S
Sept. 5	10 2 14	251 47′ 11	9 41 17 N
Sept. 17	8 31 42	255 3 5	24 18 50
October 3	10 27 5	259 22 57	35 23 39
Apparent motion in 36 days	0 42 35	10 2 59 Towards the Eaft	41 32 31 Towards the North

The

The planet which we announced in the account of the labours of the laſt quarter, diſcovered by Dr. Olbers, of Bremen, has alſo engaged the attention of all aſtronomers.

It was obſerved by C. Mechain till the 28th of Auguſt, and a ſufficient number of its poſitions was obtained to determine the elements of its orbit in ſuch a manner as to enable us to find it again ſome months hence, when it will appear in the morning after iſſuing from the rays of the ſun. C. Burckhardt, adjunct of the board of longitude, preſented ſome to the claſs, which he calculated, taking into account even the perturbations which this planet experiences from the principal part of the reſt. Theſe elements repreſent very well all the obſervations hitherto made. C. Vidal, director of the obſervatory of Toulouſe, placed under a ſky ſo favourable to aſtronomy, followed the planet of Olbers with the ſame attention and conſtancy which he employed in the obſervations of Mercury, which are ſo difficult; and he ſent to the claſs forty, with a table containing twenty-three ſelect determinations of its right aſcenſion and declination, and a chart of its apparent route from the 19th of May to the 23d of Auguſt.

In this period of time it paſſed over about 17 degrees in right aſcenſion and 5 in declination.

It appeared to C. Vidal as a ſtar of the ninth magnitude, and exhibited no trace of that nebuloſity with which comets are always accompanied.

NATURAL PHILOSOPHY.

Obſervation of a remarkable Phænomenon of Terreſtrial Refraction.

The moſt remarkable of the phyſical phænomena next to thoſe which inſpire moſt men with terror, are thoſe ſingular appearances which are produced ſometimes by the reflection or refraction of parts of the atmoſphere, and towards which the attention of philoſophers has been directed by the obſervations of C. Monge.

This circumſtance reminded C. Dangos of an effect of terreſtrial refraction which he witneſſed at Malta in 1784.

On the 20th of March, about one in the afternoon, he learned, by loud ſhouts, which reſounded from all the ſtreets of the town, that a new iſland had ariſen in the channel of Malta. Having aſcended to one of the terraces of the obſervatory, he indeed obſerved a very white tract of land in the middle of the water, the form of which was nearly that of a right cone irregularly truncated. The illuſion was ſo complete, that ſome of the ſailors had reſolved to go and reconnoitre

connoitre this iſland in order to take poſſeſſion of it. Its figure, colour, and particularly its ſituation, in the line which joins Malta and Mount Ætna, made C. Dangos ſoon perceive that it was nothing elſe than the appearance of the ſummit of that mountain, always covered with ſnow, which ſome extraordinary cauſe had brought conſiderably nearer, lowering it at the ſame time very much below the level of the water.

The publicity of this phænomenon did not permit C. Dangos to obſerve it with more preciſion. A multitude of curious ſpectators, whom he could not get rid of, crowded the terrace. But this aſtoniſhing ſpectacle appeared again on the 17th of April 1785, at ſix in the morning; a time when the indolent, not being awake, could not interrupt the diligent philoſopher in his retreat.

On this occaſion, the apparent iſland, which was better defined than that of 1784, ſeemed to be 15′ 17″ below the horizon, which correſponds to a diſtance of about 18000 yards: it ſeemed then to recede and to riſe up; after which it became confuſed for a moment, and Ætna re-appeared in its real place. The coaſts of Sicily, which had been hitherto concealed, were fully ſeen, and remained viſible during the reſt of the day.

C. Dangos, without attempting to explain this phænomenon, thinks that the humidity of the atmoſphere, of which he that day perceived very ſenſible ſigns, had a great ſhare in it; and that obſervations of the hygrometer ought not only to be added to thoſe of the thermometer and barometer to determine the refrangent force of the atmoſphere, but ſome day may ſupply the place of each other.

Going back to the beginning of the laſt century, we find, in the memoirs of the Academy of Sciences, "that the mountains of Corſica, ſeen from the coaſts of Genoa and Provence, ſeem at certain hours to plunge into the ſea." The author of the memoir which we here analyſe, ſaw the ſame appearance when at the Iſles d'Heyeres in 1778: but this phænomenon was not ſo well defined as that which he relates.

[To be continued.]

ACADEMY OF DIJON.

In the public ſitting on the 6th of September laſt, this ſociety, after adopting the plan of its labour and fixing the nature of its occupations, thought proper to change its title into that of *Academy of the Sciences, Arts, and Belles-Lettres.* It was of opinion that this denomination, more general and

 more

more expreffive, would preferve much better the remembrance of that illuftrious affociation to which it has fucceeded, and in whofe fteps it propofes to tread.

C. Lefchevin read a report on the difcovery of the phænomenon of fcintillation by the collifion of charred wood. Three fucceffive explofions took place in the courfe of four months in the powder manufactory of Vonges, notwithftanding all the precautions employed to avoid them. The frequent return of thefe events induced government to fend to the fpot C. Lemaitre, infpector-general, to inquire into the caufe of thefe accidents. Having affured himfelf that no part of the machinery was deranged, and that no foreign fubftance had been introduced into the mortars, he endeavoured to verify the fufpicions entertained in regard to the employment of charcoal in fticks. He recollected, that under certain circumftances he had obtained fparks by the collifion of charred wood: he therefore made a trial, and, after three or four ftrokes, excited three ftrong fparks. This fact ferves to account for the explofions; it explains why they do not happen more frequently, and points out in what manner explofions may be totally prevented, by adding one caution more to thofe already employed, namely, to pulverize the charcoal ufed in the manufactory of gunpowder *. C. Lefchevin terminates his memoir with the following reflection:—"Heat and light difengaged from a combuftible body being the more abundant as the combination of oxygen with the body is ftronger in a given fpace of time, it feems to refult from the different circumftances of the phænomenon I have defcribed, that a very flight degree of heat only is required to effect the combination of oxygen with charcoal, and the combuftion of the latter."

C. Potel, in a memoir on bleaching, communicated to the fociety interefting details refpecting the new method fubftituted for the old one for bleaching linen, &c. He examined the different agents which have been recommended for fome years paft; gave an account of the refult of the experiments he tried to afcertain the value of each of them; and concluded his memoir by pointing out the moft advantageous; fuch as *odorous oxygenated muriatic acid* and *cauftic alkali in vapour*, which are thofe employed in his eftablifhment. He fhowed that the ufe of *fulphuret of lime* without any mixture is abfolutely improper for bleaching; and how ill-founded is the fear of thofe who reject the new

* In moft of the gunpowder manufactories in England, if not in all of them, the practice, we believe, has long been to pulverize the charcoal alone: yet explofions ftill take place.—EDITOR.

procefs

proceſs becauſe they ſay it *burns the cloth.* He proved that if the operation is performed by an intelligent and careful artiſt, the cloth gains inſtead of loſing. The author acknowledges that in theſe different proceſſes the agent is always the ſame, namely, *oxygen,* which combining with the colouring principle renders it ſoluble in the leys employed, which then become much more effectual.

The uſe which C. Potel made of *oxygenated muriatic acid gas* conducted him by accident to many trials and experiments which are of the utmoſt importance. He has diſcovered that this ſubſtance may be employed with the greateſt advantage in all caſes of *aſphyxia.* Several rats which had been found drowned, were placed on a table on which ſome of this gas was depoſited: ſoon after the rats diſappeared, and concealed themſelves in a corner of the room, except one which remained in the neighbourhood of the apparatus: it had been reſtored to life, but, having ſuſtained ſome injury in its feet, it was not able to follow the reſt. C. Potel caught theſe animals, reduced them again to a ſtate of aſphyxia, and, having ſubjected them to the action of the gas, ſaw them reſuſcitated before him. He repeated the experiment with the ſame ſucceſs in cats: in the laſt place, in imitation of Dr. Storch, who tried on himſelf the action of hemlock, this young chemiſt was induced to try on himſelf the efficacy of his new method, and his boldneſs was crowned with ſucceſs. The academy has appointed commiſſioners to aſcertain in a certain manner the property of this gas in caſes of aſphyxia.

C. Degouvenain gave the reſult of a great number of experiments he made on acetous fermentation, and which led to the demonſtration of two points in theory not before proved by any poſitive fact; one of which, when the author publiſhes his proceſſes, will ſerve as a guide to thoſe deſirous of making good vinegar. In the mean time he has applied his diſcovery to the advantage of domeſtic economy; and being convinced that the efficacy of aromatic vinegar depends much more on its acid nature than the aromatous ſubſtances with which it is accompanied, he made ſome which to be ſaturated required from 130 to 150 parts of potaſh in a thouſand, whereas the ſtrongeſt before known (that of Maille) abſorbs only 114.

Good wine combined with oxygen by a ſeries of ingenious proceſſes peculiar to himſelf, is the only ſubſtance he employs for making vinegar; and the reſult, according to the report of the commiſſioners of the academy appointed to examine it, is, that it is in every reſpect ſuperior in quality to the moſt

 celebrated

celebrated hitherto known. This vinegar may be carried to any country, and will keep any time without fear of alteration. It possesses also another advantage, which is, that it costs only half as much as that known under the name of Maille.

XXIX. *Intelligence and Miscellaneous Articles.*

VACCINE INOCULATION.

Dr. Pearson's second and last Evidence.

Mercurii, 14 Aprilis, 1802.

Admiral BERKELEY in the Chair.

DR. PEARSON was called in and examined, and stated, that Dr. Heberden * authorized him to state, on the authority of Dr. Lind, and Mr. Battiscombe of Windsor, that there is now living near Windsor a person (the son of an apothecary,) who many years ago was inoculated for the cow-pox.

Did Dr. Heberden inform you whether this inoculation was performed from one human being to another, or from the virus taken immediately from the cow?

A. This is a question I cannot answer.

What further facts do you know affecting Dr. Jenner's claim of being the promulgator, or inventor of vaccine inoculation?

A. I have admitted Dr. Jenner was the gentleman who first set on foot the inquiry into the advantages of the vaccine inoculation; but I apprehend that the practice of vaccine inoculation, which was first promulgated by Dr. Jenner, has been established almost entirely by other practitioners, and that his new facts, or what I consider to be new, have been, in my opinion, disproved by subsequent observers; and that in consequence of those facts being disproved, together with the very extensive experience of other persons, we owe the present practice of the vaccine inoculation.

Will you inform the committee who those practitioners and persons were to whom you refer?

A. The cow-pock inoculation, after Dr. Jenner's book was published in May or June 1798, which contained seven or eight cases, (the whole result of his experience,) was not practised by any person, that I know of, till January 1799; neither Dr. Jenner, nor any other person that I could find, being in possession of matter: but in January 1799, in con-

* See Dr. Heberden's Evidence, annexed to this of Dr. Pearson.

sequence

ſequence of a general inquiry, which I had inſtituted immediately after Dr. Jenner's publication, information was given of the cow-pock diſeaſe breaking out in two of the cow ſtables near London; and from theſe ſources Dr. Woodville and myſelf collected matter, by which, in the courſe of about three months, not fewer, I think, than about 300 perſons were inoculated, in addition to the ſeven or eight caſes of Dr. Jenner, then the whole ſtock of facts of inoculation before the public. Beſides carrying on the inoculation ourſelves in this manner, we diſſeminated the matter throughout the country, in particular to Dr. Jenner* himſelf; and particularly alſo, I within that time iſſued a printed letter, directed to upwards of 200 practitioners in different parts of the kingdom, containing thread impregnated with cow-pock matter. In the courſe of this practice we already learnt that young infants might be inoculated with ſafety; which I conſidered to be then a new fact, Dr. Jenner not having had the experience, and being apprehenſive of ſerious † conſequences from inoculating them.

Secondly, That the inoculated arms, ſo far from requiring cauſtic or eſcharotic, or other topical applications, according to Dr. J., were ſooner cured than in the inoculated ſmall-pox: That Dr. Woodville's publication, in June 1799, appeared, containing the caſes of upwards of 400 inoculated, up to that time: and in Auguſt 1799 I publiſhed a ſtatement of inoculation, referring to many practitioners who had furniſhed me with reports of inoculation with matter which I myſelf had furniſhed: among theſe I beg leave to mention Mr. Relſon, of Seven Oaks; Dr. Mitchel, of Chatham; and Dr. Harriſon's caſes; as communicated to me by the right honourable ſir Joſeph Banks: and by that time I had alſo introduced it into the army, through the hands of the ſurgeon-general, Mr. Keate; and reports frequently came into my hands, by his direction, from the army. I had alſo by that time introduced the vaccine inoculation into many parts of the continent, and received reports of the ſucceſsful practice of it; in particular, from Dr. De Carro, of Vienna. In addition to theſe teſtimonies contained in the paper above alluded to, is the reſult of my own practice in three pariſhes of poor people inoculated under my ſuperintendance; ſo that in that paper, I be-

* See Dr. Jenner's Letter in Dr. Pearſon's Inquiry 1798, in which he ſays no matter can be had. Dr. Jenner, both in letters to Dr. Woodville and Dr. Pearſon, owns this matter excited the genuine cow-pock.—*Note of the Evidence.*

† This is alſo acknowledged in Dr. Jenner's Letter to the Evidence in February 1799.

lieve, it will be found that 2000 cafes had by that time been afforded for the public by Dr. Woodville and myfelf, and the perfons with whom I was in correfpondence, and who are mentioned in the papers alluded to. By this time, too, fome difficulties appear to have been removed which had been occafioned, in a great meafure, by fome facts ftated to the public by Dr. Jenner. In particular, I publifhed experiments of inoculation in the paper alluded to:—1ft, Of inoculating perfons with the cow-pock who had undergone the fmall-pox, to fhow that they could not take the cow-pock after the fmall-pox, contrary to Dr. Jenner: 2dly, Experiments to fhow that perfons could not take the cow-pock both locally and conftitutionally who had already gone through the cow-pock, alfo contrary to Dr. Jenner: 3dly, Many perfons had by this time made experiments to fhow that the cow-pock did not originate in the greafe of horfes' heels, as Dr. Jenner had afferted. Thefe fentiments will be found in a printed ftatement, which I beg to deliver in as publifhed by me.

In the fpring of the year 1799, whilft the above-ftated evidence was collecting, a fecond publication appeared from Dr. Jenner, adding nothing but a few cafes of inoculation further of the cow-pock, but recommending cauftic or efcharotic applications to the inoculated parts in the cow-pock, not found neceffary by myfelf or the medical perfons alluded to in my evidence: and I confider that the diftinctive characters of the cow-pock were underftood better by fome of the above alluded to perfons than by Dr. Jenner.

The vaccine inoculation was next confiderably eftablifhed by the Cow-pock Inftitution, of which I was one of the founders, the arrangement for which commenced at the very clofe of the year 1799; which Inftitution has been the principal office, I apprehend, for fupplying the world in general, and the army and navy in particular, with matter; and where a regular regifter is kept of each of the cafes inoculated, more fully and accurately than had been done any where before or fince that time; where the authenticity of the cafes, from the nature of the inftitution, is eftablifhed in a manner that, I apprehend, will be confidered as unexceptionable. This appears from a regifter of above 700 cafes already entered, and open to the infpection of the fubfcribers. By this time, namely, the clofe of the year 1799, I think I can make it appear that about 4000 perfons have been inoculated by Dr. Woodville, myfelf, and correfpondents, which can be referred to. I here clofe my evidence, as I confider it of very fmall importance, comparatively, what was done by others after this

this time, all the facts that I recollect of ufe in practice being by this time eftablifhed, as they have been fince confirmed.

Did you never hear of inoculation having been performed by Mr. Cline *, with matter furnifhed by Dr. Jenner, previous to the time you began to practife vaccine inoculation?

A. I cannot recollect diftinctly.

Were not feven or eight cafes of Dr. Jenner alluded to by you, cafes of inoculation from one human being to another?

A. Some of them were; fome were not.

Had not many, or a large majority of your firft cafes, variolous-like eruptions?

A. The matter, which had never been in the Small-pox hofpital, and which I myfelf took from the cows at the two cow ftables above alluded to, fcarcely ever afforded any eruptions like the fmall-pox; but when I obtained matter to fupply my correfpondents in the country, not having enough of my own, but obtaining it from the Small-pox hofpital, it frequently, according to the reports of my correfpondents, and in a few cafes where I ufed it myfelf, did produce fuch eruptions.

Was not the matter, or virus, which you diftributed, found great fault with on account of the eruptions it produced?

A. No, it was not found fault with; but many people were difappointed, as they expected that one of the advantages attending the inoculation was to be exempt from the eruptions.

Did not thefe eruptions, which were produced by your matter, very much difcourage practitioners and the public, and very much retard the progrefs of the new inoculation?

A. I fhould think it did not.

Do you not know there is a cafe in Dr. Jenner's † firft publication of his having inoculated a child of eleven months old?

A. I believe there is one cafe.

Did not Dr. Woodville and yourfelf take the vaccine matter in Gray's-inn Lane, for the purpofe of commencing your experiments, from a perfon fully marked with the fmall-pox?

A. No fuch cafe is in my recollection.

Have thofe facts ftated by you to militate againft Dr. Jenner's declared opinions remained uncontradicted by him? Does he ftill maintain them, or has he publicly retracted them?

A. I think he has not retracted them. [Withdrew.

* The Evidence afterwards found there had been a fingle cafe, but from which no one had any benefit by matter, nor was it publifhed till the following year.

† See note, p. 181, on the inoculation of infants.

Dr. Heberden's Evidence.

Dr. Heberden, being called to ſpeak to the ſtatement made as above written, ſaid, "That all he knew upon the ſubject was, about three years ago Dr. Lind, of Windſor, mentioned to him, in converſation, there was living, near Windſor, a young man, apprentice to an apothecary, who, when a child, was inoculated with vaccine matter by his father, who was an apothecary in the weſt of England. With reſpect to Mr. Battiſcombe he could not ſpeak, having heard nothing of it." —On this extract, from the minutes of the committee of the houſe of commons, the following remarks have been publiſhed: "In his (Dr. Pearſon's) examination of the 14th (April) the authority of Dr. Heberden is made uſe of to prove what on that gentleman's examination *was found completely erroneous, for he could not ſpeak to what Dr. Pearſon aſſerted he could; and of Mr. Battiſcombe he had no knowledge.* On this it is unneceſſary to make any comment; the concluſion muſt be obvious."

Theſe aſſertions, made from the words of Dr. Heberden's evidence, muſt appear unwarrantable by merely publiſhing this gentleman's explanation ſubjoined, obligingly communicated at the requeſt of Dr. Pearſon, who is conſcious that he had been ſufficiently correct in the ſtatement above given on the authority of Dr. Heberden.

"Dr. Heberden acquieſces in the correctneſs of his printed evidence, with the addition of only two words, viz. "having heard nothing of it *from him.*" In fact, Dr. Heberden was acquainted with Mr. Battiſcombe, but received his information reſpecting the vaccine inoculation from another quarter. Still it is true, that when Dr. Heberden mentioned the circumſtance to Dr. Pearſon upon Dr. Lind's authority, he corroborated his ſtatement by adding, that Dr. Giſborne had been made acquainted with the ſame account through Mr. Battiſcombe. So that Dr. Heberden may, in effect, be ſaid to have related the circumſtance to Dr. Pearſon upon the united teſtimony of Dr. Lind and Mr. Battiſcombe; though, his information in the latter caſe not having been derived *immediately* from that gentleman, he could not, with propriety, produce to the committee the authority of Mr. Battiſcombe for what he had heard upon the ſubject."

How to inoculate ſeveral hundred Perſons with the Matter of a ſingle ordinary Vaccine Pock.

A member of the Vaccine Inſtitution mixed the fluid of a ſingle cow-pock with a drachm meaſure of water of about the

the temperature of 70° of Fahrenheit. Of *three* subjects inoculated with this diluted matter, two took the disease in the usual way. The remaining third was inoculated in each arm with one puncture with this diluted matter, and also in each arm, in like manner, with undiluted cow-pock matter; but all these four punctures failed to produce the vaccine disease, the subject being an adult, and probably had had the small-pox.

Letters from Bassora of the 17th of June, from S. Mairesty, the British consul at that place, and Dr. Milne, physician to the factory, addressed to Dr. De Carro, of Vienna, confirm the happy result of the vaccine inoculation, which has been introduced into several parts of the East by the zeal of Dr. Carro. This beneficial practice has been introduced not only at Bagdad but also at Bassora. At the latter the consul set the first example by causing his own son to be inoculated; and from the end of April to the 17th of June the operation had been performed on forty subjects with the best success. Dr. Milne inoculated not only the sailors on board some ships destined for Bombay, but supplied a merchant who was travelling to Mascate with vaccine matter for that district.

THE PLANET OF OLBERS.

Circumstances have been much more favourable for determining the orbit of this planet than for that of Piazzi, an arc four times as large. A great number of observations made during six months, with great exactness, notwithstanding the difficulty of observing so faint an object, and an inclination of orbit much more considerable, give more precision to the results of calculation.

C. Mechain and Messier observed this planet till the middle of the month of August; the former, with a telescope which was not even mounted on a parallactic machine, which greatly increases the difficulty of observation. The comet which C. Mechain then discovered having obliged him to interrupt his observations, C. Messier continued to observe it alone till the 24th of September: he even tried to observe it on the 16th of October; but the vicinity of the horizon, and particularly the smoke of the chimneys which surrounded the observatory, rendered the observation too uncertain to be turned to any use. All these observations agree with an uncommon precision, and far superior to what could have been expected from an equatorial sector; C. Lalande having found the difference of 30″ in two consecutive observations of Mercury made with a large equatorial sector by an able astronomer: it appears also that this planet has no where been observed so long as at Paris.

I have

I have again carefully calculated the perturbations of the new planet. They are exceedingly numerous; neverthelefs I have obtained only an approximation very far diftant from that perfection to which aftronomers afpire. The application of fo many equations to calculation is attended with feveral difficulties, and requires many trials, principally on account of the great inequality. I have not yet finifhed them, but I hope it will be a gratification to aftronomers to be made acquainted with the primitive orbit which I had calculated without employing perturbations, and corrected according to the lateft obfervations; a labour which was interrupted only for two days by the refearches. I began employing the perturbations—

Node 172° 27′ 35″—inclination 34° 38′ 0″—longitude of the perihelium 121° 12′ 19″: on the 4th of April 1802, its motion + 2·3″ per day.

Mean anomaly, April 4th, at 10h. 51′ 17″, 42° 21′ 9″.

Great femi-axis 2·769915; eccentricity 0·2463.

Sidereal revolution 1683 days 20 hours.

Thefe elements reprefent the five obfervations in the following manner:

Errors	Apr. 4.	May 20.	July 3.	Aug. 5.	Sep. 20.
Helioc. in long.	+ 1·4″	+ 1·0″	− 1·6″	− 0·6″	− 6·0″
——— in lat.	0·0	− 2·7	− 3·5	+ 13·5	− 18·3
Geoc. in lat.	-	-	-	+ 11	− 12

Obfervers—Von Zach, Lefrançais-Mechain, Mechain, Meffier, and Burckhardt.

With thefe elements it is found that the planet on the 4th of Feb. 1803, at midnight, will have 267° 41′ right afcenfion, and 5° 38′ north declination; which differs only a few minutes from the pofition which Dr. Gaufs deduced from his elements. That able aftronomer could employ obfervations only to the 8th of July, and ftill propofes to rectify his elements by later obfervations.

I hope this refult will be confirmed when I have determined an ellipfe by employing the perturbations.

BURCKHARDT,
Nov. 13, 1802. of the Bureau of Longitude.

TRANSIT OF MERCURY OVER THE SUN.

The weather on the 9th of November was favourable to the wifhes of aftronomers, who had an excellent opportunity of obferving this phænomenon. For the information of our philofophical readers we prefent them with thofe obfervations of the tranfit which have reached us. In a future number we fhall give other details refpecting it.

Utrecht,

Utrecht, Nov. 10.—M. van Utenhoven obſerved yeſterday at the obſervatory of this academy, the ingreſs of Mercury at 12 hours 17 minutes 53 ſeconds, and the egreſs or the end of the tranſit of the planet over the ſun's diſk at 12 hours 19 minutes 28 ſeconds true time. M. Timmers of Rotterdam, a ſtudent here, obſerved the paſſage of Mercury over the meridian to be 15 ſeconds after the ſun's limb. He obſerved alſo ſeveral times the contact of the Sun and Mercury on the horizontal and vertical threads of a quadrant by Bird, in order to calculate the time of the conjunction according to the method of L'Iſle le Cadet. This phænomenon, which will not be viſible again in this republic till the 4th of May 1832, was rendered much more important by the appearance of a great many ſolar ſpots; a collection of ſuch ſpots, one or two of which ſeemed to be larger than Mercury.

Leyden, Nov. 10.—Yeſterday morning I had the ſatisfaction, with M. Biſdom, M. van der Meer, and ſeveral of my pupils, to obſerve at the obſervatory of our univerſity the paſſage of Mercury over the ſun's diſk. Mercury it appears muſt have been on the ſun's diſk before ſun-riſe, as the clouds prevented us from ſeeing that luminary till half after nine. The ſun having then broke through the clouds for ſome time, the planet was plainly ſeen on the ſun's diſk as a black, round, ſharply defined body, and could be eaſily diſtinguiſhed from the ſolar ſpots, a great many of which were then viſible on the ſun's diſk. The planet took its courſe under a great many of the principal ſpots, and, when it approached the ſun's limb, ſeemed to have a ſomewhat elongated form. I obſerved the contact at the time of ingreſs to be at 12 hours 15 minutes 6 ſeconds, and at the time of egreſs at 12 hours 16 minutes 40 ſeconds, and therefore that of the planet's was 12 hours 15 minutes 53 ſeconds, true civil time. The planet employed 94 ſeconds from the time of ingreſs to that of its egreſs, which agrees very well with calculation if the diameter be taken at 11 ſeconds. I previouſly obſerved the planet's paſſage of the meridian with our meridian circle on the 8th of November, 23 hours 43 minutes 8 ſeconds mean time. I have no doubt that this tranſit will enable aſtronomers to improve or confirm the tables of Mercury.

Van Beeck Calkoen.

Enſchede, Nov. 13.—Obſervation of the tranſit of Mercury over the ſun's diſk at Enſchede on the 4th of November 1802, with the day teleſcope and an achromatic teleſcope, which magnifies the diameter 50 times, the clock being brought to true time by a meridian line: but there

was

was no opportunity for taking correſponding altitudes of the ſun.

Enſchede lies 50° 16′ north latitude and 7′30″ in time eaſt from Amſterdam. At ſun-riſe I ſaw the planet a good way from the eaſtern limb on the ſun's diſk. There were a great many ſpots on the ſun's diſk, and particularly on the weſt ſide, about 10 in the morning. The ſky was clearer, though it was cloudy in the weſt. We were, however, able to follow the planet in its paſſage. About 11 the ſky became clear in the ſouth; but about 10 minutes after noon a very thick cloud proceeded from the north, which threatened to deprive us of all hope of ſeeing the egreſs. A few minutes before the planet came in contact with the ſun's limb, I took the ſmoked glaſs from the teleſcope, and ſaw clearly the interior contact of the ſun's limb, at 12 hours 22 minutes 10 ſeconds true time; but in a few minutes the weſtern limb of the ſun was covered by a thick cloud, ſo that no obſervation could be made of the exterior contact of Mercury with the ſun's limb.

The planet when on the diſk ſeemed to be ſurrounded by a ſmall luminous circle. The ſun's limb alſo at the time of interior contact ſeemed to quiver, and, as it were, to ſwell up a little. L. NIEUWENHUIS.

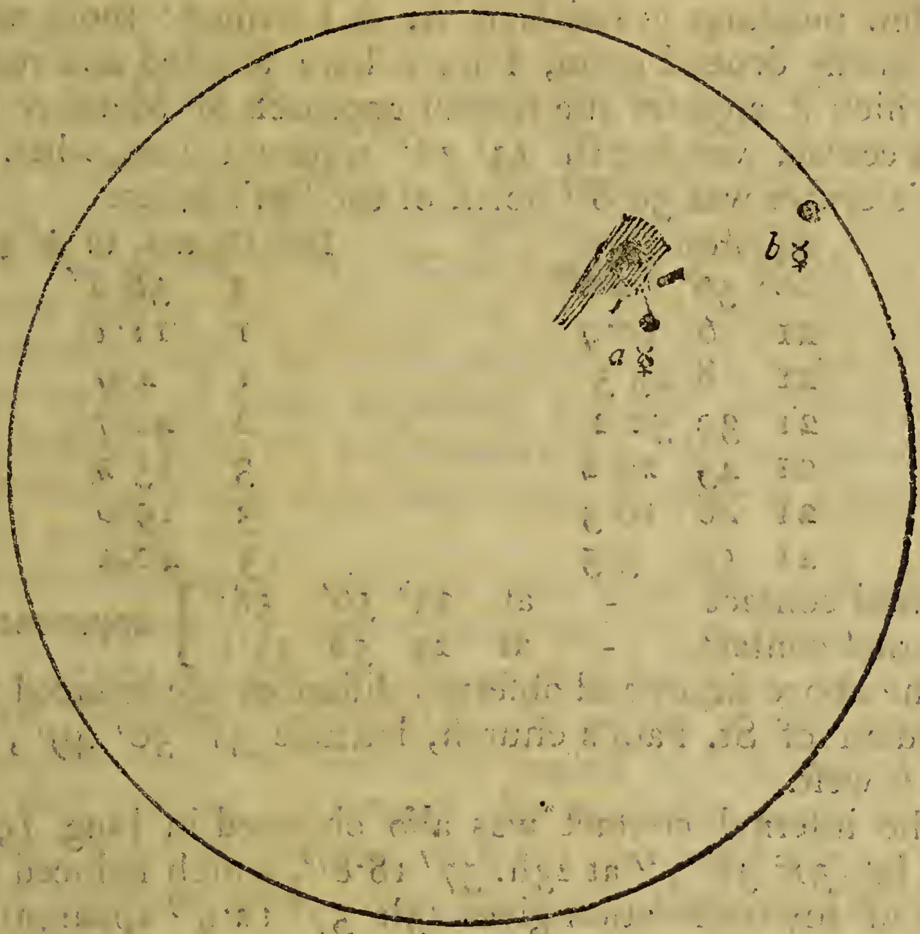
Paris, Nov. 9.—The paſſage of Mercury over the ſun's diſk was obſerved this morning, for the 19th time. The weather was exceedingly favourable, and aſtronomers enjoyed, in the completeſt manner, the ſight of this curious phænomenon. I was the more anxious to have a view of it, as I ſhall never ſee it more, ſince the next will not take place till the 5th of May 1832; for I do not reckon thoſe which will be inviſible in Europe. I had the ſatisfaction of obſerving it in the ſame place where it was obſerved for the firſt time, Nov. 7th, 1631, by Gaſſendi, one of my moſt illuſtrious predeceſſors in the *Collége de France.* Mercury emerged from the ſun at 8 minutes paſt noon, which agrees to a minute with my tables of Mercury, on which I have been employed for forty years. That day, remarkable to aſtronomers, is much more ſo on account of the regeneration of France. LALANDE.

From a Correſpondent.

SIR,

If the ſubjoined ſketch and account of Mercury's tranſit on the 9th inſtant, and his contact with the penumbra, or light part of the largeſt ſpot on the ſun that day, be worth inſerting in your valuable Magazine, the inſertion may perhaps

lead to further diſquiſition, and will much oblige a lover of aſtronomy, who is a conſtant reader of your Philoſophical Magazine *.



Apparent Time.

Firſt contact with the light part at *a* -	11h	2m	50s
Central contact - - -	11	4	24
End of contact - - -	11	5	22
Firſt contact of Mercury with the ſun's limb	11	57	13
Central contact - - -	11	57	54
End of contact - - -	11	58	17

Mr. Tilloch.

From another Correſpondent.

Nov. 8, 1802.—At 20h. 15′ apparent time, having fitted a priſmatic dark glaſs to an achromatic teleſcope of Dollond's, magnifying about 65 or 70 times, I ſaw Mercury upon the ſun's diſk, extremely diſtinct, and well defined. As Mercury was then approaching very faſt towards the ſun's centre,

* This correſpondent is requeſted to furniſh us with the longitude and latitude of his obſervatory, the method by which he aſcertained his time, and the nature and power of the teleſcope he made uſe of.

and

and the body of the ſun appearing pretty ſteady, I began to take ſome diſtances with a micrometer I had previouſly applied to the teleſcope for that purpoſe. Upon trial, however, I found the ſun's limb ſo very tremulous, that I could take but few meaſures ſo ſatisfactorily as I wiſhed: thoſe which I can chiefly depend upon, I have here ſelected and reduced, by which it appears the neareſt approach of Mercury to the ſun's centre, was at 21h. 13′ 38″ apparent time, when Mercury's centre was 59·8″ north of the ſun's centre.

Apparent Time.	Diſt. Centres. ☉ & ☿
20ʰ 56′ 2·6″	1′ 58·6″
21 6 10·9	1 11·1
21 8 25·5	1 4·9
21 39 50·2	2 40·7
21 45 29·2	3 15·2
21 46 16·3	3 19·0
21 50 3·5	3 40·4

Internal contact - at 23ʰ 56′ 58″ } apparent time.
External contact - at 23 58 35·1 }

The above times and obſerved diſtances are reduced to the meridian of St. Paul's church, latitude 51° 30′ 49″, long. 23·1″ weſt.

The internal contact was alſo obſerved in long. 19·24″, weſt lat. 51° 31′ 7″ at 23h. 57′ 18·8″, which reduced to the time of my obſervation gives 23h. 57′ 12·9″ apparent time. The gentleman who made this obſervation informs me that the houſe in which he was ſituated was in ſuch a continual ſhake from carriages paſſing by, that he could not be certain of the contact to leſs than a few ſeconds; alſo that the method by which he got his time was by equal altitudes taken under the like diſagreeable circumſtances.

TO THE EDITOR.

Reſpected Friend,

I muſt beg room for a few lines to obviate any offence to a reſpectable body by the erroneous addition of F. L. S. to my name, which I meet with in p. 55 of laſt Magazine. I am neither fellow nor aſſociate of the Linnæan Society, and, notwithſtanding the inſertion of a little piece, which has been favourably received by that body in their laſt volume of Tranſactions, am not, nor have been, a candidate for a place therein. Thy ſincere Friend,

L. Howard.

We are ſorry to have made the miſtake alluded to by Mr. Howard. It aroſe from a very natural aſſociation of ideas,

ideas, which might eafily miflead.—His partner in bufinefs Mr. Allan, is a worthy member, and himfelf a meritorious contributor to the labours of the Linnæan Society.

GALVANISM. Paris, Oct. 14.

C. Aldini, a native of Italy, and nephew of the celebrated Galvani, to whom we are indebted for the difcovery of that electricity called the Galvanic, repeated, a few days ago, in prefence of the commiffioners of the National Inftitute, and yefterday at the Oratoire, in prefence of the Galvanic Society, the principal experiments; in confequence of which he afferts, with juftice, that the ideas of his uncle refpecting animal electricity ought not to be entirely rejected, to adopt exclufively thofe of Volta refpecting metallic electricity. It refults, indeed, from the experiments of C. Aldini, that there is an animal pile and an animal circle, as there is a metallic pile and metallic circle.

The experiments of which we were witneffes, and which prove his opinion in a rigorous manner, are as follow:

1ft, The fciatic nerves of a frog being laid bare, as is ufually done, for fubjecting them to the action of the arming and metallic circle, he contented himfelf with bringing together and putting in contact the mufcular parts of the thighs and paws of the frog with the uncovered nerves, and contractions of the animal took place as in the ufual Galvanic experiment.

2d, He took the frog by the paws, holding it with one hand by the mufcular parts, making the nerves hang down; he touched with a finger of the other hand the nerves thus fufpended; and the contractions took place as by the metallic circle and Galvanic apparatus.

3d, For the third experiment, he made his affiftant hold the frog by the paws or by the mufcular parts; applied his finger to the nerves, without giving his hand to the affiftant; and the contractions did not take place. He then gave his hand to the affiftant; and, having applied a finger of the other hand to the nerves, the contractions took place as in the other experiments. Thefe experiments were repeated on feveral frogs.

In the laft place, feveral experiments were made on the head of a large dog feparated from the trunk, which had no relation either to the animal circle or pile; but afterwards they took one of the above frogs, and, by putting a finger into the fpinal marrow of the dog, prefenting with the other hand the nerves of the frog to one of the mufcles of the trunk

of the dog, the contractions of the frog took place as with the Galvanic apparatus; which, according to the obſervations of the author, leaves no doubt reſpecting the exiſtence of the animal circle and pile. Theſe ingenious experiments will doubtleſs furniſh to their modeſt and learned author a multitude of other ideas on the animal economy, particularly reſpecting the nervous fluid, &c., which leave him the care and glory to explain.

For my part, I came out from theſe experiments charmed and tranſported with admiration at the ſimplicity of the means which nature employs in its phænomena that ſeem to us the moſt complex. It appears to me proved, that to perform a prodigious number of its operations it contents itſelf with one electric fluid, which it puts in motion at the ſurface and in the interior of the earth by a kind of Galvanic piles, which produce, as I have explained in my lectures, a great number of the phænomena of the animal and vegetable kingdom; and that it has employed the ſame agent in the animal kingdom, by organizing the nerves and muſcles as Galvanic piles to execute moſt of the operations of animal life by the ſame agent, and by means of theſe ſubſtances the nerves and the muſcles, which it has organized in ſuch a manner, that they diſcharge, in regard to each other, the ſame functions as the different metals the contact of which excites a permanent current of the electric fluid; which is the moſt valuable diſcovery for which we are indebted to the pile of Volta.

It had hitherto been tried, without ſucceſs, to excite a permanent electric current without friction; and the machine of Hierne did not accompliſh this end in a ſatisfactory manner.

This permanence of the electric fluid, for which we are indebted to the Voltaic pile, is a diſcovery, then, no leſs admirable perhaps than that of C. Aldini; and both have given to the natural ſciences a ſtimulus which will aſtoniſh future ages, if the reſults be followed, as there is no reaſon to doubt.

MASUYER-DIN, Profeſſor in the
Special School of Medicine at Straſburgh.

XXX. *On Capillary Action.* *By* JOHN LESLIE, *Esq.**

THE principle of univerfal attraction, having finally fubdued every fpecies of oppofition, is now fixed on a bafe never to be fhaken. Many are the fruitlefs attempts to explain its operation by the impulfive energy of fome invifible impalpable fluid: but thefe owe their birth to metaphyfical prejudice, and are juftly difcarded by all fober and reflecting inquirers. Nor is the fuppofition of fuch mechanical *intermedia* merely repugnant to the fpirit of true philofophy; it is directly contradicted by recent difcoveries. When an impulfe is communicated to any mafs or fyftem of particles, it is transferred along the chain by a feries of pulfations, each particle in fucceffion feeling the action and fuffering a momentary derangement. Motion is therefore propagated in the fame manner as found, and the celerity of its tranfmiffion muft depend on the mutual diftance of the affected particles and the relative force with which they are connected together. In moft cafes, indeed, that come under obfervation, it is impoffible to diftinguifh the interval between the origin and the termination of an impulfe, which is thence very generally imagined to act fimultaneoufly through the whole line of its communication. But, though the rapidity of tranfit outftrips the quicknefs of our fenfations, it ftill requires a certain lapfe of time. Nay, on the juft eftimate of this principle,—on the duration of effect,—(refined as it may appear,) depends the theory of the tools and manipulations ufed in moft of the mechanic arts. Nor is the exiftence of fuch a fmall yet finite moment a mere abftraction; it is the neceffary refult of the known properties of matter. Were we to fuppofe that the fun acts on the planets by the intervention of fome fubtle medium diffufed through the celeftial fpaces and endowed with the moft powerful elafticity, a very confiderable meafure of time would be required to propagate the impreffion. If we afcribed to that fluid, for example, the relative denfity and elafticity of hydrogenous gas, almoft five years would be fpent in conveying the impulfive energy to the earth. But it is proved, by fome late and very nice refearches of M. Laplace on the irregularities of the planetary motions, that the attractive force of the fun is exerted fimultaneoufly at all diftances. The notion of an intermediate fluid is thus entirely precluded.

The principle of *action at a diftance* is therefore a primary

* Communicated by the Author.

and effential law of nature. Gravitation itfelf is only a branch of that law, from which are derived the various conftitution and all the diverfified properties, of bodies. The mutual action exerted between two elementary portions of matter is, in the language of modern algebraïfts, always fome *function* of their diftance. At proximate diftances, this function muft change repeatedly, and with different degrees of intenfity, from pofitive to negative, or from attraction to repulfion. Hence the varied ftructure and compofition of bodies. It is indifferent whether we confider the elementary portions of matter as points, atoms, particles, or molecules. Their magnitude, if they have any, never enters into the eftimate. When the diftance is confiderable, the law of action becomes confounded with that of gravitation, and is of fuch remarkable fimplicity as to qualify it for the happieft application ever made of the mathematical fciences. Could we afcertain the gradations at near diftances, we might determine the ftructure, affinities, and mutual operations of bodies, with the fame certainty as we compute the revolutions of the planets. But fuch a difcovery feems placed beyond the reach of the human faculties. However, by a fcrupulous attention, we may difcern certain inftances of the approximation and tranfition of corpufcular forces. And I hold thofe facts to be the more valuable, as they form the intermediate link between the mechanical and the chemical phænomena.

Of this kind I confider the *afcenfion of water and other liquids in capillary tubes*. This fact is fo familiar that I need not ftop to defcribe it. It was firft noticed by the Academy *del Cimento*, at Florence, early in the 17th century; but feems not to have been much regarded in the fequel. After the promulgation, however, of the Newtonian fyftem, the fubject was revived with ardour. It was juftly confidered as affording intuitive evidence of the reality of attraction. About the beginning of the 18th century, Hawkfbee, in England, made fome excellent experiments on capillary action; and Muffchenbroeck purfued the fame courfe in Holland. Similar experiments were performed in France; but in that country the Cartefian philofophy was then in the height of its career, and no deliberate attention could be paid to facts which appeared to countenance an oppofite fyftem. About the fame period Dr. Jurin publifhed, at London, an elaborate differtation on the caufe of capillary action; and his explication of that curious fact feems, either from conviction or fupine acquiefcence, to be almoft univerfally adopted. It is repeated in all the elementary books of natural philofophy. It continues to maintain the fame credit: no fufpicion is ever ftarted of

of its ſolidity, and ſcarce an attempt is made to eſtabliſh another theory. The celebrated Clairaut, indeed, has caſually touched on the ſubject of capillary action in his Treatiſe on the Figure of the Earth; but his inveſtigation of that phænomenon is loſt in a chaos of calculation. M. Lalande, who is ſo active a writer, has tried to unravel it: the aſtronomer does not appear, however, to have ſucceeded. I content myſelf with this general notice of his little tract; for to refute it is much eaſier than to render it diſtinctly intelligible.

But, when we coolly conſider Jurin's account of capillary action, we are ſurpriſed that it could obtain ſuch ſucceſs. It is in appearance ſimple indeed, and plauſible; but it will not bear the ſlighteſt examination. The water is conceived to be kept ſuſpended in the tube by the attraction of the ſmall ring of glaſs immediately *above* the interior ſurface. But I aſk, Ought not the ring *below* to exert an equal force in a contrary direction, and conſequently deſtroy the effect of the former? This argument it ſeems impoſſible to elude, and to expand it would be ſuperfluous. We muſt therefore regard the common account of capillary action as entirely without foundation.

It may well furniſh matter for ſurpriſe and mortification to remark ſuch a glaring overſight committed in the very porch of the phyſical ſciences. But if we extend our obſervations we ſhall ſoon be convinced that the popular branches of philoſophy, with all their ſuppoſed improvement, are in general ſtill very defective and erroneous. Thoſe flowery departments have been left to the culture of a ſecondary order of men, whoſe imagination was commonly more powerful than their judgment. In every age the vigour of genius has been directed to the ſublimer parts, and thoſe united efforts have reared a ſtupendous monument of the penetration and reſources of the human mind.

In attempting to explain the mode of capillary action, the chief difficulty ſeems to ariſe from the prejudice that a *vertical* attraction is neceſſary to account for the elevation of liquor in the tube: yet this is aſſuredly not the primary direction of the force; for, the action of glaſs being evidently confined within very narrow limits, that virtue muſt be diffuſed over the internal ſurface of the tube, and conſequently muſt exert itſelf *laterally*, or at right angles to the ſides. Nor is it difficult to conceive how a lateral action may cauſe an aſcent. We know that in fluids a force impreſſed in *one* direction is capable of propagating itſelf in *all* directions. The tendency of the liquor to approach the glaſs, muſt occaſion it

to ſpread over the internal cavity of the tube, and, conſequently, to mount upwards.

But let us view the ſubject a little more cloſely. Suppoſe I put a drop of water upon a horizontal plate of glaſs: it will quit its globular form, adhere to the glaſs, and ſpread out till it has covered the plate with a thin aqueous film. What then is the cauſe of this phænomenon? It is ſurely not the mere incumbent weight of the water; for that would not have been ſufficient even to ſurmount the mutual adheſion of the particles of the fluid, or their natural tendency to agglobulate. Beſides, the ſame preciſe effect will take place if the drop be applied to the under ſide of the plate. The water therefore diffuſes itſelf on the glaſs in the ſame manner as if it were urged by the preſſure of a column acting againſt that ſurface. Its attraction to the glaſs is equivalent to this ſuppoſed preſſure, and is productive of the ſame conſequences. But why ſhould the mere tendency of the water to the ſurface of the glaſs occaſion a diſperſive motion? The reaſon is, that the external particles could not approach without ſpreading themſelves and extending the film: and analogy will inſtruct us, that the attraction of water to glaſs muſt increaſe in proportion to the proximity of its approach, till it has reached the term of cloſeſt union.

If the plate be held vertically the aqueous film will ſtill adhere, but only to a certain limited elevation, depending on its thickneſs. I reckon the force of ſuſpenſion correſponding to each inch of width, or of the extent of the horizontal linear boundary, as equal to the weight of about the 100th part of a cubic inch of water. Hence, if the film was only the 1000th part of an inch in thickneſs, it would maintain a height of ten inches; but if its thickneſs amounted to the 100th of an inch, it would ſubſide to an elevation of one inch.

Suppoſe I now dip the plate perpendicularly in a baſin of water, the film will ſuffer a very conſiderable modification. A new portion of water greedily attaches itſelf to the film, and depreſſes it by the load of additional weight. The curve of protuberance ſeems nearly an inverted parabola, and conſequently the preſſure to be ſuſtained is only the third part of what would obtain if the column had been of uniform thickneſs. The relative force of attraction is therefore $= \frac{3}{100}$; and if we conceive the height to be equal to the breadth, which appears nearly the caſe, either of them will be denoted by $\sqrt{\frac{3}{100}}$, or a little more than the ſixth part of an inch: a concluſion which correſponds ſufficiently with obſervation.

If

If two glafs plates, held near each other and parallel, be dipped in water, the water will mount in the included fpace. The aqueous protuberance is now confined, and the afcent of the column is therefore greater; befides that the effect is doubled by the united action of both oppofite furfaces. Each furface acts only upon a thin film; but, fince the force is fpent in fupporting the particles which adhere to this, the height of the column muft evidently be inverfely as the weight fufpended, or the diftance between the glafs plates. Imagine the interval between thofe plates to be the 100th part of an inch: then each furface may be confidered as acting againft a column of the thicknefs of the 200th part of an inch; and fince the force of attraction is equivalent to the weight of the 100th part of a cubic inch, the correfponding afcent muft be two inches. In like manner, if the interval were only the 200th part of an inch, the height of the column muft be four inches. In general, put d = the diftance between the plates, and $\frac{1}{50d}$ = the height of the column.

The fame reafoning is applicable in the cafe of capillary tubes. The attraction of the internal furface is exerted on a thin circular lining; but this force is diluted and attenuated by the preffure of the water which adheres to the film and occupies the cavity of the tube. A circle, it is well known, is equal to a rectangle which has the circumference for its bafe and half the radius for its altitude: confequently the attractive power of the glafs will produce the fame effect as if it acted fimply againft a column whofe thicknefs is one-fourth part of the bore of the tube. But we have already feen that the meafure of force is expreffed by $\frac{1}{100}$; and hence, if d denote the width of the bore, the height at which the water will be fufpended in the tube will be $= \frac{1}{100 \times \frac{1}{4}d} = \frac{1}{25d}$. Thus the altitude of fufpenfion in capillary tubes is the double of what obtains with parallel plates whofe mutual diftance is the diameter of the bore.

The fufpenfion of water in capillary tubes muft depend entirely on the fmallnefs of the fuperior orifice. Nor will the effect be in any degree altered, however much the lower part of the tube be enlarged: for, by the laws of fluids, the preffure is proportional merely to the altitude of the column; and this preffure is balanced at the upper extremity by the adhefive force of the film, which attaches itfelf to the infide of the tube.

If a capillary tube be inſerted through another tube, and both dipped in water, it will riſe not only in the capillary bore, but in the interſtice between the two tubes. Even though the diameter of the outer tube be conſiderable, the water muſt form a ſenſible elevation in the intermediate ring; and this elevation will be determined by comparing the extent of the oppoſite ſurfaces of glaſs with the intercluded ſpace on which their action is ſpent. The abſolute aſcent in the capillary bore continues the ſame; but, if we eſtimate it from the external protuberant ring of water, it will appear evidently diminiſhed. Conceive the outer tube to be fitted with a bottom, and the whole to be removed from the baſin: the effect will ſtill remain the ſame, and conſequently the apparent altitude of the fluid in the capillary bore will be diminiſhed. Let d denote this bore, d' the diameter of the tube, and d'' the width of the outer tube, or rather that of the ciſtern in which the capillary is plunged: then it may be eaſily inveſtigated, from the principles already explained, that the height to which the water will riſe is $= \frac{1}{25}\left(\frac{1}{d} - \frac{1}{d'' - d'}\right)$ in inches.

If the tube has its lower orifice not too wide, on removing it from the ciſtern in which it was immerſed, a drop of water will adhere, and the column in the capillary bore will remain at the ſame height. Its ſuſpenſion, we have ſeen, is produced by the lateral adheſion of the internal film, to which a cylinder of water attaches itſelf. If the drop at the extremity be diminiſhed by any cauſe, ſuch as the contact of bibulous paper, the column will ſubſide; for the tendency of the water to agglobulate then counteracts, in ſome degree, its capillary extenſion in the tube. Cover a horizontal piece of glaſs with a fine film of water, and bring the tube with its charge to touch it, the water will immediately deſert the cylindrical cavity and ſpread over the film. The attraction which the vertical column of water, joined to its weight, bears to the expanſive horizontal film, overcomes its adheſion to the narrow film that lines the inſide of the tube. We here contemplate the extreme caſe; but it ſhould be remarked in general that the mutual attraction of the particles of water or other fluids muſt, to a certain degree, diminiſh their aſcent in capillary tubes, ſince that force tends to agglomerate the parts, and conſequently oppoſes any ramifications or filamentous prolongations of the fluid. This reſiſtance, it might

be ſhown, is, like the capillary action itſelf, inverſely as the width of the bore. The two oppoſite effects, being thus proportional, are confounded, and their difference only is obſerved. In the caſe of glaſs, the capillary action greatly preponderates: one conſequence of this is the concavity remarked at the top of the column; a clear proof that the lateral exceeds the central adheſion. If the upper ſurface were perfectly flat, thoſe two forces would be in exact equilibrium. But the convexity of the top of the column proves that the fluid has a greater attraction to its own particles than to glaſs. Such is the caſe with quickſilver, which, inſtead of aſcending in capillary tubes, ſuffers a depreſſion according to the ſame law. This remarkable fact has been aſcribed to ſome repulſion exiſting between quickſilver and glaſs. But I regard ſuch a ſuppoſition as equally unneceſſary and improbable. The ſame conſequence would, no doubt, take place with water in poliſhed tubes of ſteel or braſs. If I place a drop of water on a ſmooth ſurface of metal, or a globule of quickſilver on a plate of glaſs, neither of them will ſeem at all affected by the contact, but will obey the attraction of their own particles, and therefore affect the ſpherical form.

Hence the mercury in a barometer can never mount to its true height; and the error will be the more conſiderable in proportion as the tube is narrow. If two tubes of different diameters be carefully filled and planted in the ſame baſin, the mercurial column will ſtand viſibly higher in the wider tube. This aberration has been generally neglected, though it muſt evidently affect the barometric calculation of the altitudes of mountains *.

On the ſame principle I would explain the familiar experiment of a needle ſwimming on the ſurface of water. It is ſuperfluous to have recourſe to any ſuppoſed repulſion. The internal coheſion of the water oppoſes its diviſion; a gentle cavity is formed, which, preſſing upwards, ſupports the needle.

Above twenty years ago, that able chemiſt M. Guyton-Morveau, examining into the nature of chemical affinities, attempted to determine the relative attraction of a variety of ſubſtances, from the force required to detach ſmall plates of glaſs or metal from their contact with water or quickſilver. The

* Suppoſe the mercurial column at the bottom of the mountain to be 30 inches, at the ſummit 15; and let the depreſſion be equal to the 20th of an inch, which correſponds to ordinary tubes. Then the corrected columns are 30·05 and 15·05; but the ratio of theſe numbers is different from that of 30 to 15, and conſequently it will give a different altitude. The common calculation will repreſent the mountain above 90 feet higher than it ought to be.

 idea,

idea, though not logically accurate, was ingenious, and had a certain degree of fuccefs. It is evident that the force meafured was not ftrictly that of mutual attraction, but only the weight of the protuberant mafs of fluid the moment before its feparation. Nor does the height of this column depend on its mere adhefion; for it can never exceed the cohefive force of the fluid molecules to each other. When the plate, whatever may be its attractive power, is raifed above a certain limit, the attached column breaks, and part of it adheres to the plate, while the reft falls back into the body of the fluid. Thus, thofe experiments can afcertain the adhefion of the plate only when it is comparatively very fmall; in other cafes they meafure fimply the integrant attraction of the particles of the fluid. If capillary action be regarded as approximate to chemical affinity, this may be always determined, with facility and with fufficient accuracy, by obferving the afcent in two parallel plates fixed at fome minute but known diftance from each other.

The elevation of a liquid in a capillary bore is produced by its fpecific attraction to the matter of the tube. With different fubftances the effects are confiderably diverfified: alcohol, for example, rifes little more than a third part of the height to which water reaches. But the flighteft alteration in the conftitution of the fubftance will fometimes occafion a very material difference of effect. Thus I find that, on diluting the alcohol, the afcent of the liquor is fcarcely at all augmented; but, if I reverfe the procefs, and add a few drops of alcohol to the water, the capillary column will fuffer a remarkable depreffion. On this principle might be conftructed a very fimple hydrometer for meafuring the ftrength of weak liquors. And I would invite chemifts to try capillary action with different faline and metallic folutions, as I am confident that many curious facts would thus be difcovered. Nothing could exceed the fimplicity of fuch an inftrument. It is only neceffary to choofe a fine calibred tube, and to have it divided on the outfide into equal parts by the point of a diamond, or marked with enamel colours. On plunging it into the liquid and then removing it, the precife effect would be indicated by the fufpended column. I have no doubt but that fuch an inftrument, in the hands of a fkilful operator, would be brought to mark, with fufficient exactnefs, the proportion of ingredients contained in a compound fluid, and might in fome cafes fuperfede the trouble of analyfis itfelf.

The afcent of water through pounded glafs, fand, and other powdery fubftances, is juftly explained by capillary action.

action. The effect is produced by the attraction of the numerous proximate facets; and it is the more notable, as the aggregate surface is very large in comparison with the interstices to be filled up with humidity. But the absorption of water by bibulous paper, linen, or flannel, though commonly referred to the same cause, is of a very different nature. From close observation I am convinced that in those instances there occurs a real though not a permanent change of constitution: the solid begins to assimilate itself to the qualities of the combined fluid, and becomes softer and more translucid. By means of an instrument, contrived to measure the smallest alteration of volume, I have proved decisively that the union of water or oil with paper or linen is accompanied with a general contraction or concentration of the mass. Nay, applying a delicate thermometer, I perceived a very sensible extrication of heat invariably to take place during such combinations. And this effect was the greater in proportion to the previous dryness of the solid. Thus I have sometimes produced a heat of ten degrees by moistening saw-dust which had been parched before the fire. An absorption of this kind is strictly a chemical process: the internal structure of the solid is altered, and a force is developed very distinct in quality and degree from what obtains in capillary action. The contemplation of such facts may serve to extend our ideas of chemical agency. The state of fluidity is essential to its operation; but that quality is required only in one of the ingredients, and the result of the combination may be indifferently a fluid or a solid. Copper will imbibe quicksilver and become only more brittle; and, on the other hand, quicksilver will dissolve a small portion of copper without relinquishing its fluid character. Nay, if the one species of combination can be produced, we may safely infer the existence of the other. Thus all stones are found to contain water incorporated in their substance, altogether distinct from what may insinuate itself in their accidental crevices. If we reverse the combination, therefore, and suppose the fluid to predominate, we shall conclude that water is to a certain degree capable of dissolving all sorts of stones. And if, disregarding the authority of disputed systems, we candidly examine the numerous facts that occur in geology, we cannot hesitate to admit the justness of the proposition. I would not venture, however, to maintain that water is singly capable of dissolving the hardest stone; for the cohesion of the integrant molecules will, in some cases, oppose a force superior to the attraction of the water. But the process may be

be aſſiſted by the concurrence of other agents that tend to diſunite the ſolid. In general, the action of chemical affinities admits of compariſon with the application of mechanical force. There are ſome obvious facts which at once illuſtrate and confirm this principle. For example, carbonic gas, combined with water, enters into the compoſition of marble; but neither of thoſe fugitive ſubſtances, however concealed or diſguiſed, yet abandons its ſpecific character. On the application of intenſe heat their elaſticity becomes developed with irreſiſtible force, and they make their eſcape, leaving the ſtony baſis in the dry cauſtic ſtate of quicklime. I ſhall mention one other fact which exhibits the play of chemical affinities. Charcoal, it is well known, has the property of imbibing air; and I have proved from experiment that this impriſoned air exiſts in a compreſſed or condenſed ſtate. But water, being applied to the charcoal, will be immediately abſorbed by ſuperior attraction, and will diſlodge the air, which now recovers its uſual expanſion.

Sulphuric acid, potaſh, and in general all the deliqueſcent ſalts, have the power of attracting moiſture from the atmoſphere. They exert a real chemical action which overcomes the adheſion of humidity to the air. But I have remarked the ſame property to obtain more or leſs in a great variety of ſubſtances; in paper, linen, flannel, wood; nay, in ſtones and earths. The water, thus abſtracted from the atmoſphere, penetrates into their ſubſtance and diſappears. The ſurface of glaſs ſhows, in a limited degree, a ſimilar power. I have obſerved that, on the approach of evening, bits of glaſs became covered over with minute globules long before the ſurrounding air was abſolutely damp. About the temperature of freezing I have noticed this dew to appear on the ſurface of the glaſs, when my hygrometer ſtill indicated a dryneſs of five degrees. But in higher temperatures the effect was even more ſtriking; and I have ſeen the ſides of a tumbler covered with dew when the ambient air poſſeſſed 15 degrees of dryneſs. In thoſe caſes, however, the humidity is merely detached from the air by the action of the glaſs, and it remains adhering to the ſurface without being abſorbed into the vitreous maſs. The effect cannot, with any appearance of probability, be imputed to a ſuppoſed alkaline effloreſcence; for it was obſerved with fine flint glaſs, and the dew collected was always perfectly taſteleſs. When poliſhed metals were expoſed, they never received any dew till the atmoſphere was abſolutely damp. They ſeem therefore to be entirely paſſive.

This ſingular property of glaſs is certainly a modification

of

of capillary action: it muſt therefore obtain in other kindred ſubſtances. I am inclined to refer it to the ſame cauſe, however apparently ſubtle, which has ſo forcibly ſtruck me in ſome other reſearches. It is well underſtood that phyſical is different from mathematical, contact. In the former there is a finite interval whoſe extent is various, depending on the mutual relation of the bounding ſurfaces. The degree of approach is greater in ſome caſes than in others, or the contact is of a more perfect kind. I have proved lately, I think to demonſtration, that air is ſeparated from the poliſhed ſurface of metal by a much wider interval than from glaſs or other ſubſtances. The air therefore, charged with its humidity, approaches ſo cloſe to the glaſs, that the latter exerts moſt powerfully its ſpecific attraction, and detaches the minute globules of water. Paper and other vegetable ſubſtances, though ſaturated with moiſture, and therefore capable only of diſplaying capillary action, ſeem to poſſeſs the ſame property as glaſs.

I conſider the power of abſtracting humidity from the atmoſphere as of important conſequence in the vegetable economy. Plants may thus inhale liquid nutriment, when the ambient air is ſtill far from being diſpoſed to part with its watery ſtore. And we have ſeen that heat promotes the effect. Hence certain vegetable tribes, without feeling the beneficial influence of rain or dews, are yet capable of exiſting in the ſultry arid plains of Arabia. They extract a ſcanty ſupply of moiſture from the air by a ſort of chemical proceſs. Perhaps the organic ſtructure of the plant may conſpire with its phyſical quality in augmenting the effect.

The celerity of the flow of liquids in capillary ſyphons depends chiefly on a circumſtance which, I believe, has not hitherto been noticed. If we conſider with a little degree of attention the motion of water through a narrow paſſage, we ſhall ſoon be convinced that it is not regular and uniform. The obſtruction at firſt experienced occaſions a certain accumulation, which at length overpowers reſiſtance and cauſes a partial acceleration. In this manner, a ſort of continual reciprocating tide is produced in a ſeries of pulſes more or leſs intricate. This curious effect is diſtinctly viſible in artificial *jets-d'eau*. But the ſame thing may be perceived in every current of water. Hence the varying dimpled ſurface and the gentle murmur, of brooks. The volume of water continues the ſame; but its contours and flexures are inceſſantly changing, and ſoothe the fancy by exhibiting a picture of animation. After performing a certain cycle, however, the ſame irregularities are again repeated: and hence the muſical cadence

dence of rivulets, so closely associated in our minds with luxurious ease and the calm pleasures of pastoral life.

If we examine carefully the ascent of mercury in a fine thermometer, we shall find that it mounts by a succession of starts. It seems to force itself along by a sort of vermicular motion. Nor does the resistance depend much on the friction experienced against the sides of the tube; it is owing chiefly to the waste of force in impressing a narrow thread of liquid with those concatenated contractions and dilatations indispensable to progressive motion.* I must observe that the term *fluidity* itself is merely of relative import. A solid body may soften by insensible gradations, and pass into the state of a fluid. In this new condition the particles are indifferent to position, and therefore easily admit of intestine motion. But such a property implies an extension of the sphere of mutual connection. In a large system of molecules, the slightest alteration in the situation of each is sufficient to produce a total change of arrangement. It is otherwise when the group is very limited. The composition of a fluid may thus be conceived to resemble a long spring, which bends easily and without risk under the smallest pressure; while the structure of a solid may be compared to a short spring, which yields only to the application of a great force, and is then liable to break. But the action of heat extends this imaginary spring, and promotes softness and fluidity. Thus a bit of sealing-wax, held near the flame of a candle, gradually loses its angles and protuberances; an evident proof that the sphere of mutual cohesion is enlarged. And every person must have remarked that oil, during the heat of summer, becomes apparently thin, and flows with facility. Nay, water itself undergoes a similar change of constitution, though it eludes ordinary observation. I bend a thermometer tube, with rather a wide bore, into a siphon, which I insert into a tumbler of cold water, and count how many drops fall in a minute. I then empty the tumbler, and fill it to the same height with hot water; and, replacing the siphon, I find that the drops, which are still of the same size, succeed each other much more rapidly than before, insomuch as sometimes to form a continual streamlet. I conclude, from several trials, that the velocity of the flow is at least six times greater near the boiling point than on the verge of congelation. But the difference may be rendered much more striking in another way. The height to which liquids are projected is proportional to the square of their initial velocity. Provide, therefore, a glass tube three or four feet long and more than half an inch wide: by the help of a blow-pipe, draw

out the end into a tapering capillary bore, and, a little above this, bend the ſhoulder back parallel to the tube. Then, holding the tube perpendicular, fill it with cold water, and break off by degrees the ſlender ſtem till the water begins to ſpirt up perhaps half an inch. Now plunge the lower end of the tube, for the ſpace of a minute or two, in boiling water, and, on removing it, the jet will appear to dart almoſt to the height of three feet, but will gradually ſubſide as the heated portion of water is expended.

The ſame experiment will ſucceed, though in different proportions, with alcohol and even mercury. Yet all theſe are commonly deemed perfect fluids; nor can we doubt that the application of heat will in every caſe increaſe the tenuity of the liquid ſubſtance, and heighten its degree of fluidity. If water thus experiences ſuch a change, the effect muſt be proportionally greater on the dilute ſolution of mucilaginous and ſaccharine matter which conſtitutes the ſap of plants. The return of ſpring, by the mere phyſical influence of its warmth, will promote the flow of the juices deſtined for the nouriſhment of the vegetable tribes. That genial ſeaſon, therefore, not only reanimates the principle of life, and ſtimulates the organs of ſecretion to elaborate their fluids, but quickens the circulation of thoſe fluids through the fine ramifications of the ſap-veſſels. Hence the rapid growth of plants in the hot climates. Hence, likewiſe, the quick vegetation remarked within the polar circle, where, for the ſpace of weeks or months, the ſlanting rays of the ſun play without intermiſſion.

Verſailles,
October 9, 1802.*

* This paper was drawn up in great haſte for a particular occaſion. It is now printed without alteration, although the author is conſcious of its defects in point of unity and arrangement.

XXXI. *Ob-*

XXXI. *Obſervations on the Salt of Bitumen; the Bit-Noben of the Hindoos.* By JOHN HENDERSON, *Eſq. Surgeon on the Bengal Eſtabliſhment* *.

Sal Indus vel ſubniger, vel ſubrufus, obſcurus omnibus fortior.
Meſſue, c. xvi.

Et alius eſt Indus, qui eſt niger, non nigredine napticitatis.
Avicenna, lib. ii. c. 624.

THE ſaline ſubſtance which has lately been imported into Britain under the name of *ſalt of bitumen*, is not, as might be inferred from the title, a natural production, but an artificial preparation of great antiquity invented by the Hindûs. It is known in India by various appellations †; but the trivial name, by which it is familiar to thoſe who have reſided any time in that country, is *khala nimuc*, or black ſalt. It is met with in every village in large irregular lumps, for the moſt part of a dark brown colour.

It has a ſtrong ſaline taſte, with a peculiar ſenſation diffuſed over the mouth, which is not eaſily deſcribed. At firſt, the taſte is diſagreeable: but I have been told by thoſe who were in the habit of uſing it, that it not only becomes pleaſant, but is often taken to remove a diſagreeable taſte in the mouth. When the ſalt is perfectly dry, it has ſcarcely any perceptible ſmell, but when moiſtened it ſends forth a ſtrong ſulphureous fœtor.

It diſſolves readily in a ſmall portion of water, forming a ſolution of a greeniſh colour, which emits a ſtrong ſulphureous ſmell, reſembling bilge water, or the fouleſt gun-ſcourings. By expoſure to the air, the ſmell gradually abates, and the greeniſh tint diſappears, the liquor becoming as clear as the pureſt water: when this has taken place, if the ſolution

* Communicated by the Author.—This preſents a curious ſpecimen of the Hindoo phyſic; and further, it may ſuggeſt to Britiſh practitioners the trial of hydro-ſulphurets alone or in combuſtion, as in the caſe of the preſent ſalt, in many untried diſeaſes.

† By the Hindoos it is called *bit-noben*, *padnoon*, and *ſooncherloon*; in Arabic and Perſian MSS. *melk*, *melk-nuſt*, *melk-aſwed*, *nimuci-nuſt*, *nimuciſed*, and *nimuci-hindi*. It is the *ſal-naphthicus Indus vel Indicus* of the Latin verſions of the Arabian and Perſian authors; the *pharmacopeia auguſtana* of the earlier editions of the *Pharmacopeia Londinenſis*, &c. It muſt be obſerved, that all the formulæ of which it is an ingredient in the different pharmacopeias, are copied from the Arabian authors; and therefore I doubt much whether it was ever imported into this country before, or even into Europe in any conſiderable quantity, for I find no particular account of it in any of theſe books. It is, perhaps, the *ſal-aſphaltites* and *ſodomenus* of Pliny and Galen.

tion has been pretty ſtrong, on pouring out the water, the inſide of the veſſel in which it was contained is found lined with a cruſt of a dark brown colour; a phænomenon obſerved in moſt ſulphur wells: this will be beſt diſcovered if the experiment is made in a glaſs veſſel.

A ſilver ſpoon laid over a freſh ſolution of the ſalt became diſcoloured in the courſe of a few hours; and a little ſugar of lead put upon the ſhank of the ſpoon, and kept over the ſolution during the night, was found in the morning conſiderably blackened. A few drops of the nitric acid added to the freſh ſolution cauſed a milky appearance, and a little acetate of lead poured into a glaſs of it cauſed a precipitate that filled nearly one-third of the glaſs. The hepatic gas is in ſuch abundance, that, by expoſing a ſtrong ſolution in a tumbler to the air, the ſulphur becomes at once evident, in the cruſt with which the glaſs is uniformly found to be lined.

After a ſolution of the ſalt had been expoſed to the air till it became perfectly clear, a quantity of it was poured into a china plate, and gradually evaporated by the heat of the ſun: there remained in the plate a number of cubical cryſtals, evidently pure common ſalt, without any other reſiduum. The ſalt, from the taſte, and ſome curious phænomena attending it, appeared to be of an uncommon degree of purity.

From theſe experiments it appears that ſalt of bitumen is chiefly compoſed of common ſalt and hepatic air, or, in the language of modern chemiſtry, of muriate of ſoda and ſulphureous hydrogen gas, the two principal ingredients that impregnate the mineral waters of Aix la Chapelle, Baden, Harrowgate, Moffat, and moſt of the celebrated ſulphureous ſprings in Europe.

There are very few ſulphurated ſprings, either hot or cold, in Hindooſtan: I only heard of one, "in the province of Burdwan," in all the country from Hurdwar to Point Palmiras. How far the Hindoos have ſucceeded in diſcovering the deſideratum for preparing them artificially appears from the above analyſis, and will be confirmed by comparing a ſolution of the ſalt with the ſulphurated waters at their ſources. All the European proceſſes and machinery for imitating theſe waters have been directed to the impregnation of water with gas diſengaged from *hepar ſulphuris*, which produces an imitation of the ſulphurated waters mentioned by Dr. Coggan in his Travels on the Rhine, but not of Moffat or Harrowgate: it may perhaps be found that air diſengaged from common ſalt is different from that of *hepar ſulphuris*, and in ſulphur ſprings the ſalt ſeems to be a very univerſal ingredient. Not only the waters already mentioned, but thoſe of Corſtorphine, St.

St. Bernard's Well, Broughton, Deddington, Crickle Spa, Durham, Rippon, Shipton, Keddlestone, Sutton Bog, &c. &c., have all common salt for their basis. This discovery of the Hindoos is upwards of two thousand years old, and far surpasses all the attempts of modern chemists to make artificial sulphurated waters *: they have perhaps discovered the very process employed by nature in the formation of them.

The Arabians and Persians, and even the Mussulmans in India, have generally considered salt of bitumen a natural production; and those who allow that it is made in the country insist upon two kinds, the one natural and the other artificial, and that the latter is only an imitation of the natural. The Mahummedans have such a contemptible opinion of the Hindoos, that they are much more disposed to believe it dug out of the earth, or formed from the water of the Mare Mortuum, than that it is a production of Hindoo chemistry. Some of the chemists to whom I showed it in this country were also inclined to consider it as a natural production. That it is an artificial preparation I am perfectly convinced, from the information of the natives, from having seen a mass of the salt in the form of the earthen vessel in which it had been made, and from having succeeded, in a great measure, in making it: finally, Mr. Robertson, the gentleman who collected and sent it from India, writes, that the salt is manufactured in the neighbourhood of the city of Agra, where it may be had in any quantity. Although I was at considerable expense with the native chemists and alchemists, yet I must confess that I never prepared any salt equal to what was to be got in the bazar or market-place. I shall therefore not describe the different processes performed by my operators. I shall only remark one part, in which they all agreed, and that was, the igneous fusion of common salt with a very celebrated Hindoo medicine called *turp'hulla* †, or the three fruits, a name given by way of

* Even in the gaseous part, the present artificial sulphurated waters are said to be different. In the report made to the National Institute of France by citizens Fourcroy, Chaptal, &c. respecting the artificial mineral waters of Messrs. Paul and Co., they observe, 9thly, finally, "the sulphurated appeared to the committee not sufficiently impregnated with sulphurated hydrogen gas."

† *Turp'hulla* is the *atriful* of the Arabians and Persians, and the true and genuine origin of those celebrated compositions, long retained in the pharmacopeias of Europe under the title of *tryphera*; a word which seems to have exhausted the ingenuity of our lexicographers, who, I find, are fast expelling it from their lexicons and dictionaries. It never had any connection with the Greek word τρυφη, nor the *tryphera* of Scribonius Largus.

distinction

diftinction to the Chebul, Belleric and Emblic myrabolans. I muft here obferve, that there is not a particle of fulphur, alkali, or calcareous earth, ufed in the procefs. I have often tried folutions of the falt with infufions of flowers, that afforded very delicate tefts of the prefence of acids and alkalies, but never difcovered the fmalleft appearance of either.

As a medicine for man and beaft, falt of bitumen is more extenfively ufed in Hindooftan than any article of the materia medica that I know of; and, except common culinary falt, I know no medicine the confumption of which comes near it. It forms the bafis of thofe compofitions called *maffalas*, which the natives in charge of horfes, elephants, camels, and other cattle, are in the habit of demanding, once a month, or oftener, as effentially neceffary to keep them in proper condition. The Hindoos themfelves alfo ufe great quantities of it, and have frequent recourfe to it to improve their appetite and digeftion. They confider it a fpecific for obftructions of the liver and fpleen, particularly for that affection of the fpleen called in England the *ague cake* *; which is a very frequent difeafe in India, and well known there by the trivial names *peely* and *bofe*. It is a moft obftinate diforder, often continuing for years, and refifting the moft powerful remedies: after every other has failed, it has been frequently known to give way to a courfe of the *bit-noben*.

It is in high eftimation as a remedy in paralytic diforders, particularly for that fpecies of palfy where the organs of fpeech are affected. It is much ufed for different cutaneous affections, worms, old rheumatifms, indigeftion, want of appetite; in fhort, it is confidered the grand reftorative for man and beaft in all chronic diforders. Great quantities of the falt are ufed by the *falûtras*, or native farriers, who feem perfectly to underftand the principle on which its efficacy depends; for, after giving a horfe a dofe of the falt, which is done by mixing it with his food, they always give him water to extricate the gas.

* This affection is, I believe, a rare difeafe in England, and feldom treated of in medical books. In the Eaft, it is not only often brought on by long-continued fevers, but is a frequent primary difeafe, and under the titles *wurm el tehal* and *amafi fepurz* is particularly defcribed in almoft every Perfian and Arabic MS. on the practice of phyfic.

There is a remedy for the enlargement of the fpleen, now very popular in Bengal, called *Lynd's pill for the bofe*, which, from the heterogeneous ingredients of which it is compofed, has generally been confidered by the practitioners there as an ufelefs farrago: however, its efficacy has been fuch as to bring it into high repute. It was in analyfing this pill that I became acquainted with the virtues of falt of bitumen.

Mr. Lynd was a head furgeon of eminence on the Bengal eftablifhment.

XXXII. *Memoir on the Refining of Lead; with some Reflections on the Inconvenience of Ash Cupells; and the Description of a new and economical Method of constructing Cupells or Refining Vessels: read in the French National Institute. By* C. DUHAMEL, *Member of the Institute and Inspector of Mines* *.

IT is well known, that to separate silver from lead, a metallurgic process called refining or cupellation, performed in a vessel called a cupell, has been employed: it is known also that this vessel is composed either of the ashes of the bones of animals, or of those of vegetables, after they have been lixiviated, to free them from the saline matters which they may contain.

The great quantity of wood-ashes which must be employed in the construction of cupells, and the difficulty of obtaining them, long ago induced me to endeavour to discover a simpler and less expensive method of constructing the vessels in question. The old chemists having observed that lead becomes oxidated, or reduced into what is called *litharge*, when exposed to heat, or the contact of the atmospheric air, while the silver united to it retains its metallic form, nothing seemed necessary but to find the means of separating these two metals. They were conducted to the method of accomplishing this by observing that the oxide of lead, in its state of liquefaction, easily penetrates the substances which are in contact with it, and especially bone-ashes, without deforming the vessels which are formed of them. No matter, indeed, is more proper than the latter for constructing small refining cupells.

The difficulty, and often even the impossibility, of obtaining about 160 English gallons of ashes for each operation of refining on a large scale in the German furnaces, made the proprietors have recourse to wood-ashes; but, besides that these ashes are expensive, it often happens that they cannot be procured in sufficient quantity. They are even attended with one inconvenience, which is, that they come off, and float on the fused lead; the refining then fails: and this takes place every time that the ashes are badly prepared, that the cupell is insufficiently or not uniformly beat, or when the canals destined for the evaporation of the moisture are neither in sufficient number, nor properly arranged, nor covered with a stratum of scoriæ, on which is established the bottom, that receives the ashes, and which ought to be con-

* From the *Journal des Mines*, No. 64.

structed

ftructed of the moft porous bricks, in order that the water, with which it is neceffary to moiften the afhes, may penetrate them in evaporating, may proceed to the bed of fcoriæ, and efcape by the fpiracles which are at the bafe of the furnace.

To afcertain the proportion of lead in filver, it is fufficient to put fome pennyweights into a fmall cupell of bone-afhes placed under the muffle of an affaying furnace. In proportion as the lead becomes oxidated, it infinuates itfelf into the cupell, and the filver at laft affumes that vivid appearance which announces that the whole lead is diffipated, that the filver it contained is refined, and has attained to its *maximum* of purity.

In refining on a large fcale, the object alfo is to feparate the filver from the lead, but not to make the whole of the latter penetrate into the cupell, which is even impoffible; for in that cafe it would be neceffary to have a much larger quantity of afhes for the total abforption of the metal: befides, the operation would require a period ten times as long as that ufed in general for refining, and would occafion ten times the expenfe in fuel, and a much greater lofs of the metals than by the ufual procefs, where the greater part of the lead is obtained in litharge, while a portion penetrates into the cupell for about two inches of its thicknefs, which muft be fufed to revive the lead. This reduction is alfo more expenfive, and experiences a greater lofs than the litharge, which is eafily fufed, and which, without paffing through the furnace, may be employed as an article in commerce.

Lead ore and litharge may be fufed as in England, and the department of the ci-devant Brittany, in a reverberating furnace the foles or bafons of which are formed of pounded and moiftened clay. Thefe foles can ftand the action of heat and of the oxide of lead for fix or eight months of uninterrupted labour.

The durability of thefe earthen foles gave me the firft idea of the method, which I fhall hereafter propofe, for refining-furnaces, where the only thing required is to oxidate the lead to obtain it in litharge, and not to caufe the cupells to imbibe the whole of it, as is done when the object is to affay the metal in order to know whether it contains filver. In operating on a large fcale, the cupell, though of afhes, abforbs only a part of the lead, as I have already faid, obferving at the fame time that it would be much more advantageous to obtain the whole transformed into litharge, the reduction of which into lead is much eafier than that of the

 oxide

oxide contained in the ashes, which oppose fusion, and the scoriæ of which always carry with them some of the metal.

In a cupell of ashes beat into an oval circle of iron, the greater diameter of which is only five or six feet and the less one yard, the English refine from a ton to 23 cwt. of lead, which is converted into beautiful litharge, except the small portion which penetrates into the cupell, the thickness of which is only about $2\frac{1}{4}$ inches, and which is supported under the arch of the furnace by two bars of iron. A pair of leather bellows drive the litharge towards the anterior part of the furnace, from which it falls, without interruption, on the floor of the foundry, while, to fill up the vacuity left by the oxide running off, an ingot of lead placed close to the base of the bellows is made to advance gradually into the interior part of the furnace. This lead, by fusing, keeps the cupell full till towards the end of the operation.

If I have here given a short view of the process of the English, it is only to show that it is possible to perform operations of refining by employing only a small quantity of ashes for the construction of cupells. Those in question do not absorb 90 pounds of oxide in the large quantity of lead which is refined.

It is then proved that metallurgists have always endeavoured to obtain the greatest quantity possible of litharge, and little ashes impregnated with oxide; but as they thought that they ought not to deviate from the docimastic process, they have always constructed their cupells of ashes.

It has been seen that in cupellation on a small scale, lead, in proportion to its oxidation, penetrates the ashes. When no more is left, the small button of silver remains pure at the bottom of the bason under a spherical form. This operation takes place with the more celerity, as the surface of the mass is always convex in these small vessels; which allows the oxide to flow as on an inclined plane, towards the edges of the cupell, where it is immediately imbibed.

The case is not the same with cupells on a large scale, which are several yards in diameter: bellows must be applied, the wind of which serves not only for accelerating the oxidation, but also for driving the litharge towards the gutter formed for its escape.

We have remarked the inconveniences and even the impossibility of making the whole lead penetrate into the ashes of large cupells: oxidation, indeed, is not effected but in the parts of the mass exposed to the contact of the air or to the wind of the bellows; but as litharge, towards the middle of the bason, could not reach its edges, it would remain there in

in a ftate of ftagnation, and would neceffarily oppofe the formation of a new ftratum of oxide. This has induced metallurgifts to expel the litharge by the wind of a pair of bellows in proportion as it is formed, and to make it flow from the furnace.

Oxidation then takes place only at the furface of the mafs, and not at its lower part: if the cafe were otherwife, the afhes of cupells would be penetrated by the oxide to a thicknefs the more unequal, as the operation is longer; but I have always remarked, that the *teft*, or the part of the afhes impregnated with litharge, in refining on a large fcale, is not thicker in the centre of the bafon than towards its circumference, though the lead remains thirty or forty times as long in the bottom as on the edges; fince the mafs continually decreafes till the whole lead is reduced to litharge, and till nothing remains but a cake of filver at the bottom of the cupell.

If the whole lead is imbibed by the affaying cupell, it is becaufe this fmall veffel is expofed to a heat uniform in all its parts. As the cupell, in operations on a large fcale, prefents to the action of the caloric only its upper furface, the oxide imbibed ceafes to penetrate it at the place where the temperature is no longer high enough to keep that oxide in a ftate of fufion. For this reafon, the thicknefs impregnated is equal throughout the whole extent of the cupell; and this prevents the poffibility of making the whole lead penetrate into the afhes.

From the above obfervations it may eafily be conceived, that if the affaying of lead ought to be performed in fmall cupells of bone-afhes, in order that the oxidated metal may penetrate them, and be in part evaporated, the cafe is different with refining on a large fcale, where it is neceffary to accelerate the operation, and to obtain as much litharge as poffible.

I have already faid, that the wood-afhes of which cupells are made for refining on a large fcale are expenfive; that very often a fufficient quantity cannot be procured; and that befides this, part of the afhes, and fometimes the whole, feparate themfelves entirely from the fole; which occafion a confiderable lofs. I fhall add, that to give more weight and confiftence to the cupells, it is often neceffary to mix with the afhes a large quantity of fand; efpecially if the lead contains foreign fubftances, fuch as arfenic, cobalt, antimony, tin, &c. If the lead be only arfenical, after having feparated the firft fcum, a quarter of a hundred weight of iron filings or caft iron turnings are now and then thrown over the whole

 furface

furface of the mafs. This iron, being lighter than lead, floats over it and abforbs the arfenic, after which the mafs muft be fcummed: foon after, the litharge is formed without any obftacle. This method is employed in Saxony.

The neceffity of adding fand to the afhes of cupells muft have conducted to the difcovery of the following means, which I fhall here propofe.

New Method of conftructing Bafons for Refining.

Without making any change in the mafon-work of the refining furnace, called the German, care only muft be taken to form at the bottom a fufficient number of canals for the evaporation of the moifture, and to arrange them in the manner beft calculated to produce that effect. Thefe canals or fpiracles muft be covered with a bed of fcoriæ, over which a pavement is to be made of one layer of the moft porous bricks.

On this area, which muft be concave like the fole on which the afhes of common cupells are beat, place founders' fand a little moiftened; to which may be added a fifteenth part of argil, if it is not fufficiently earthy, in order to give it the requifite folidity; and the whole muft be carefully mixed. This fand muft be rammed in the fame manner as for confolidating afhes; and a refining bafon is to be formed in like manner, uniformly beat in all its parts. The thicknefs of this cupell muft be fix or feven inches: it may be formed of two ftrata, as will be feen hereafter.

After the bafon has been uniformly beat in every part, about a gallon of lixiviated wood-afhes may be fifted over its whole furface, and rendered adherent with beaters.

When the cupell is thus prepared, let down the head on the furnace and make a moderate fire in the fire-hole; which muft be maintained for feveral hours, in order to caufe a part of the water, with which the fand has been moiftened, to evaporate. The furplus will be diffipated during the operation, without any inconvenience, by canals of evaporation.

After a fufficient deficcation, raife the head and fuffer the cupell to cool a little; fpread out ftraw or hay over it, and arrange the ingots of lead, placing them gently on it that their weight may not derange the fand: it is to prevent fuch derangement that ftraw is employed, as is done in regard to cupells of bone-afhes *. When the quantity of lead neceffary for filling the cupell is arranged in the furnace, let down

* Inftead of prifmatic ingots it will be better to caft the lead in hemifpherical iron moulds. Pieces of that form are lefs liable to damage the cupell.

the

the head, and, having luted it round with foft clay, make fire in the fire-hole as for the common operations of refining.

When the lead is in complete fufion, and the mafs is covered with fcum and charred ftraw, make the fcum or drofs run off by the gutter for the litharge with a bit of board about a foot in length, in the middle of which is faftened a rod of iron of fufficient length to traverfe the furnace and about a yard more.

When the lead has been well fcummed feveral times, and begins to be red, make the bellows act, but at firft gently; arrange the nozzles of them in fuch a manner, that the wind iffuing from both may be directed to the centre of the cupell; and in order that the wind may be always reverberated on the mafs, adapt to the extremity of each nozzle a fmall round piece of iron plate. This kind of valves, which the French refiners call *papillons*, is employed for refining according to the German method. They are fufpende by hinges at their upper part: at each ftroke of the bellows they are half raifed, and they reverberate the wind on the lead, which accelerates its oxidation.

After all the drofs or fcum is removed, and when the lead has become exceedingly red, and covered with a ftratum of litharge, form, with a fmall iron hook deftined for that purpofe, a fmall gutter in the fand of the cupell, which muft be dug deeper, gradually and with caution, until the bottom of it be on a level with the mafs. The litharge then, driven by the wind of the bellows towards the anterior part of the furnace, will run by this gutter and fall on the floor of the foundry, as is the cafe in the common operations of refining.

When the refiner obferves that no more litharge remains in the neighbourhood of the gutter, he will ftop the flowing off with a fmall quantity of moiftened afhes: but as foon as the lead again becomes covered with oxide, the gutter muft be opened, and muft be dug in proportion to the diminution of the mafs, taking care that no lead efcapes, and particularly towards the end of the operation; for it would carry with it a great deal of filver, which would be loft. You muft proceed in this manner till the filver has acquired its vivid colour; taking care to increafe the fire in proportion to the diminution of the mafs; efpecially when the operation is nearly terminated, becaufe the filver then is collected together: and, as it is much more difficult to be kept in fufion than the fmall quantity of lead which remains united with it, it could be refined only in an imperfect manner at an infufficient temperature; and inftead of about a twentieth of lead, which the filver generally contains in the German refining-

 houfes,

houfes, it would remain charged with a great deal more, which would render it more difficult to proceed to a fecond operation, called the *refining of filver*, by which it is carried to the required degree of purity. The Germans call this fecond procefs *filber brennen*, burning filver.

Thofe accuftomed to the refining of lead according to the German method, will be able to perform that which I here propofe; for, though the cupell be of fand inftead of afhes, the operation muft be conducted in the fame manner.

It has been feen that the Englifh refine a large quantity of lead in a fmall cupell: in the like manner, a great deal of metal may be made to pafs by that which I propofe, if care be taken to add more metal as that which is oxidated efcapes. If we fuppofe that the cupell is capable of containing four or five tons of lead, above fixteen may be refined at one operation; which will not be attended with the inconveniences of the Englifh procefs.

I have reafon to think that a cupell of fand well conftructed may ferve for feveral operations without the neceffity of re-conftructing it each time, as is the cafe with thofe of afhes; but in this cafe, and before the lead is introduced, you muft fill up the gutter which has been made for the litharge to run off, after having removed with a chifel the kind of varnifh which the oxide of lead has left on the fides of it, in order that the new fand, fomewhat moiftened, may form an intimate connection with the old fand, which muft alfo be watered in that part before the new fand is depofited.

The long duration of earthen foles in reverberating furnaces, where lead ore and even litharge are fufed, as I have already mentioned, leaves no room for apprehenfion in regard to the action of the oxide of lead, which will act only at the furface of the cupell, and will penetrate only a very fmall part of its thicknefs.

After one or more operations of refining, this cruft muft be removed, and fufed in a furnace in contact with fuel, in order to obtain the lead. This procefs will be as eafy as the reduction of that metal contained in the afhes of common cupells, and in a much fmaller quantity. More litharge then will be obtained by the new method than the old; which is an advantage, as I have already obferved. I fhall here add, that as the fole of fand does not abforb fo much oxide of lead as that of afhes, it will not carry with it fo much filver; for it is well known that lead revived from its afhes always contains more than that which arifes from the reduction of litharge.

Inftead of fand, argillaceous earth might be employed for the

the construction of cupells, as is the case in regard to the soles of the reverberating furnaces in the ci-devant Brittany; but it would be necessary to ram this earth repeatedly for several days; otherwise it would split, and these cracks would increase by the shrinking which must result from the heat, and lead would insinuate itself into these fissures: an inconvenience which cannot take place with sand even a little earthy. I shall observe also, that a sole of earth would harden too much to allow a gutter to be dug for the passage of the litharge: in this case it would be necessary that the place destined for the oxide to run off should be constructed with sand or lixiviated ashes.

I shall add also, that it will be advantageous to employ two kinds of sand in the formation of the bason of the cupell; one kind fine like that used by founders, and the other coarser and not earthy: the latter will form the first stratum, which, after being beat with rammers destined for that purpose, ought to be about three inches and a half in thickness. The fine sand, a little earthy, must then be applied over this first stratum to form a second, which is to be rammed like the former. Both these kinds of sand must be somewhat moistened before they are introduced into the furnace, in order that they may be better heaped up, and be consolidated by the rammers.

The sand of the lower stratum, being coarser than that of the upper, will absorb the moisture of the latter in proportion as it evaporates; and it will pass without any obstacle through the canals disposed for that purpose.

The lower stratum of sand may remain in its place when a new cupell is to be constructed with fine sand, and the part of the latter, which has not been impregnated with oxide, must be mixed with new sand to form a cupell. Care must be taken in raising this sand not to touch the lower stratum; for the sand of the latter, which is coarse, must not be mixed with the other. This inconvenience may be avoided by beating over the bed of coarse sand a thin stratum of ashes, at which you must stop in removing the fine sand of the upper stratum.

It has been said that the founders' sand must be somewhat earthy, and that, if it is not, a little argil must be added to give it cohesion: but, as it is necessary that this argil should be uniformly diffused through all the parts of the sand, it must be diluted in the water with which the sand is moistened, and the whole must be carefully mixed.

It may be objected, that as cupells of sand do not absorb so much litharge as those of ashes, more time will be required to terminate the operation of refining; since, in the new process,

cess, the oxide, instead of being absorbed, ought to flow from the furnace. This circumstance needs excite no uneasiness; for the wind of the bellows, if well directed, will make the litharge flow along the gutter more abundantly than if there had been an absorption.

I have seen refiners in Germany, who, in constructing their cupells of ashes, formed in the middle of it a small circular depression the diameter of which was proportioned to the quantity of the silver which they knew to be contained in the lead subjected to the operation. By this excellent disposition no grains of that valuable metal remain insulated from the cake; the whole runs into the central bason, and forms a cake perfectly round. I would recommend this practice.

I am certain that the cupells here proposed, if carefully and properly constructed, will be attended with complete success; will be free from the inconveniences of those of ashes, and at the same time will be economical. I am desirous, for the benefit of metallurgy, that the method here pointed out may be put in practice: it will prove that we ought not to be too tenacious in adhering servilely to antient usages or to the common routine of workmen.

XXXIII. *On Painting.* *By Mr.* E. Dayes, *Painter* *.

I think it right again to repeat, that I have not observed any order in the production of these Essays. They were written as the subjects arose in my mind, and the present paper should be considered rather as an introductory address than otherwise. My motive in writing the present essay was to endeavour to remove the prejudice of those who consider the arts as a useless study, and their produce as things merely ornamental. But who, in a state of civil society, would be content with the useful or necessary? Who is he whose soul seeks not after perfection?

> The motions of his spirit are dull as night,
> And his affections dark as Erebus:
> Let no such man be trusted.

The subject of the following essay had long engaged my attention; but I had dropped the idea of writing on it, in consequence of some intelligent friends observing it would be useless, as no one could be so stupid as not to see the usefulness and influence of the arts on society. Experience,

* Communicated by the Author.

however,

however, has taught the contrary; and I have been further ſtrengthened in my reſolution by obſerving, that the French National Inſtitute, in their public ſitting of April 5, had thought the inquiry of ſufficient importance to offer it as a ſubject for the premium of a gold medal *.

Francis-ſtreet, Bedford-ſquare, November 30, 1802. EDWARD DAYES.

ESSAY VII.

On the Power and Uſefulneſs of Drawing.

I am perſuaded that to be a virtuoſo (ſo far as befits a gentleman) is a higher ſtep towards becoming a man of virtue and good ſenſe, than the being what in this age we call a ſcholar. *Lord Shafteſbury.*

IN this eſſay we have two objects in view: to ſhow the connection of drawing with painting; and to exhibit, in as clear a manner as we poſſibly can, its uſefulneſs and influence on ſociety.

But before we proceed it may be neceſſary to obſerve, that thoſe who would queſtion the utility of the arts, would be equally diſpoſed to queſtion the utility of theſe eſſays that treat about them. Of their uſefulneſs we hope to be able to offer numberleſs proofs; but they riſe ſuperior to the merely uſeful. For that which is neceſſary is neither ornamented nor elegant, becauſe neceſſity implies poverty, while ornament implies abundance. Hence architecture, as an art, does not apply to mere houſe-building.

In defence of theſe eſſays, they are ſerviceable by exhibiting the uſefulneſs of truth; and ſo far they become an object to all thoſe who wiſh to be acquainted with the ſubject handled, and to obtain a knowledge therein. But to thoſe who never think or inquire, or concern themſelves with matters of ſpeculation, or who take up with ſpeculations without examining them, or read only to confirm themſelves in ſuch as they have received, not any thing can become an object of concern, or any book be uſeful.

That man was not intended by nature for purpoſes baſe and ignoble, none will deny; and, if arguments were wanted, they might be drawn from that eternal inquiry after whatever is grand, dignified, or exalted; and, finally, after a ſtate ſuperior to our preſent terreſtrial one. For it is not too much

* We cannot help thinking that Mr. Dayes has judged well in taking up this part of the ſubject. It is of great importance, and he has rendered an eſſential ſervice not only to the art itſelf, but to its liberal profeſſors, by removing, as his arguments effectually do, ill-grounded prejudices againſt its indiſpenſable utility in civilized ſociety; prejudices which could only originate in, and be foſtered by, ignorance and ſtupidity.—EDITOR.

to

to aſſert, that we approach the Divinity in nothing ſo much as in wiſdom. Hence, as the arts are connected with wiſdom, as men become careleſs of their culture, they become equally incapable of fulfilling the duties of ſocial beings. For knowledge is what humanizes mankind; reaſon inclines them to mildneſs, but ignorance generates prejudice, which eradicates every tender feeling.

By *drawing* is meant the exact imitation of all the forms and manners which preſent themſelves to our ſight; and in knowing how to give every thing its proper and correſponding character agreeably to the ſubject conſiſts the excellence of what the artiſt terms *a good draftsman.*

Drawing, as far as it is connected with mere imitation, is a mechanical operation, and may be acquired by a perſon of very moderate talents. So may a knowledge of bodies, properties, facts, events, and fables, by reading. But the powers of invention, the *vis poetica*, which diſtinguiſhes the bard from the mere verſifier or journaliſt, the genius from the mere imitator and copyiſt, muſt be a gift from heaven beſtowed at the formation of the being. Neither this poetic energy nor the inventive powers of the artiſt can be taught in ſchools or academies; but they both may be buried in ruſt and inaction, if proper objects are not preſented to call them into motion. So the inventive powers of genius will be futile if unaccompanied by a ſkill in drawing. Without this, the learning of the painter or ſculptor cannot be ſhown to advantage: it is the *ſine qua non* by which all the other accompliſhments are diſplayed.

From what has been already ſtated, the dependence of painting on drawing muſt be obvious.

Genius has been compared to fire from flint, which can only be produced by colliſion: if ſo, ſucceſs muſt follow where nature directs and perſeverance attends. Activity is a neceſſary ingredient to enable us to obtain a knowledge in art; and ſhould we find others out-ſtep us, let us redouble our diligence, and comfort ourſelves with the recollection, that a late ſpring produces the greateſt plenty.

No one can poſſibly judge of his powers from mere ſpeculation; the teſt muſt be applied before the value of the gold can be known. Nor will inactivity ever diſcover how far our fortitude will enable us to overcome difficulties, our patience to bear diſappointment, or our induſtry enable us to range the wide field of art. For, were the arts of eaſy attainment, they would be unworthy the notice of a great mind. This ſhould induce us to increaſe our exertions in proportion to our diſappointments, remembering that to ſtrive

with difficulties is noble, but to conquer is one of the higheſt points of human felicity. It is in painting as in writing: where difficulties occur, they ariſe from not clearly underſtanding the ſubject. Hence, to be able to repreſent an object juſtly we muſt underſtand its fabrication; for it would be in vain to think of drawing the arch of a bridge correctly without knowing how it was keyed or put together, or even a baſket if we did not know how it was wove.

We ſhall now proceed to conſider the power of drawing in a point of view merely uſeful.

How limited muſt their ideas be who conſider it as "the foundation of painting" only! We know it is ſuch: for without drawing it would be in vain to think of producing an effect; as mere colour without form muſt remain a crude and undiſtinguiſhable maſs.

Drawing is not only an accompliſhment the moſt elegant, agreeable, and ornamental, but, at the ſame time that it is the foundation of painting, is of the utmoſt utility to the ſculptor, the civil and naval architect, the engraver, the engineer, the mathematician, and navigator. It alſo aſſiſts the gardener, the cabinet-maker, the weaver, &c. In ſhort, there is ſcarcely a branch of civil ſociety that is not indebted to it, from the maker of the iron rails before our houſe to the tea-urn on our table. To it we are indebted for repreſentations of thoſe elegant remains of antiquity that have contributed ſo much to the advancement of our knowledge of fine form. Volumes of verbal deſcription will never convey ſo true an idea of a thing as the moſt ſlight ſketch. Hence the ſource of much of our knowledge in antiquity, of which language could convey no adequate idea.

To be able on the ſpot to make a ſketch of a fine building, beautiful proſpect, or any curious production of nature or of art, is not only a very deſirable and elegant accompliſhment, but in the higheſt degree entertaining. To treaſure up whatever may occur in our travels, either for future uſe or to illuſtrate converſation, to repreſent the deeds of the great of former ages, to preſerve the features of our moſt valued friends, has made this art not only one of the higheſt embelliſhments of our nature, but the delight of all ages. The greateſt writers have united to praiſe, and empires to encourage it. It has been in the higheſt degree morally uſeful; and, where it has flouriſhed, conferred honour on the country. In fact, ſociety could not ſuſtain a more ſevere loſs than in being deprived of it; as many comforts, and all thoſe elegancies that adorn the preſent ſtate of our being, muſt depart with it.

What

What has been the fate of thofe people whofe lawgivers forbid the practice of one part of the elegant arts? It appears they well knew, that where art refides, wifdom will ever be of the party; and dreaded the downfall of opinions built on a falfe bafe.

Wifdom is power, and power is what preferves a nation: hence thofe who fhut the door againft knowledge are wilfully feeking their own deftruction: fuch is precifely the prefent ftate of the Turkifh empire.

> Ye gods! what juftice rules the ball!
> Freedom and arts together fall:
> Fools grant whate'er ambition craves;
> And men once ignorant are flaves. POPE.

What was the fate of Crete, that was fo renowned for her wifdom, valour, and laws? How did fhe fink under the tyranny and oppreffion of Rome? With their freedom departed their arts, their fciences, their valour, and their virtues. With the lofs of liberty we lofe all the ardour nature has furnifhed us with to ftrengthen and fupport the flame of genius and the ardent glow of valour: without it we become deftitute of vigorous refolution, and fink below the natural virtue and dignity of our fpecies.

Drawing may be faid to poffefs a divine virtue in its creative power, and to be a perpetual miracle, as it preferves the images of diftant objects, and the likenefs of thofe we love.

Without rifking our lives on the boifterous ocean, we may enjoy at home, in a fmall book, reprefentations of the fineft productions of nature and art fituated in the remoteft regions of the world.

The wealth of a ftate, and the degree of civilization of its inhabitants, are fhown in the perfection of the elegant arts: no country ever flourifhed without them.

To fpeak of the power of drawing in a very limited point of view: without it we could not have maps and charts; without them we could not navigate; and without navigation we could not poffefs the advantages of commerce. Its application to fhip-building muft be obvious, as every part is made to a fcale. As a mere power of imitation, it unqueftionably fets man at the head of creation, no other animal having made even the attempt.

The arts have not only an influence on our manners but paffions, and, taken in a national point of view, are highly ufeful. The pictures reprefenting gallant actions or noble achievements roufe and ftimulate to acts of heroifm and

public ſpirit; while thoſe of a more elegant turn exhibit examples of graceful addreſs, and incline the mind to acts of beneficence and virtue.

However much we may lament that hiſtorical painting is not ſufficiently encouraged, yet we muſt diſſent from thoſe who ſupport the old but erroneous opinion, that our love of portrait-painting ariſes from a national vanity. This ridiculous idea has been bandied about, both by foreigner and native, till many who take up with opinions without examining them have believed it true. We boldly aſſert, on the contrary, that it is national virtue that gives it birth, and a deſire the moſt rational, that of preſerving the images of thoſe we love and delight in, conſtantly before our eyes. It argues great national beneficence and goodneſs of heart. We may in ſome meaſure judge of the diſpoſition of the maſter of a houſe from the number of portraits he poſſeſſes: they cannot be likeneſſes of his enemies. Hence his choice muſt be founded on love, and not, as the antients' was, on pride and vanity. The portrait-painter therefore becomes morally uſeful by increaſing that ſocial tie that binds ſociety together, in keeping before our eyes the images of departed worth or exiſting merit. It is only thoſe who neither love nor are beloved, that have no need of the portrait-painter.

Among the number of our own national advantages, and which ſome may think ſuperior to all others, we may obſerve that the excellence of our artiſts has turned the balance of trade in our favour. For whereas we formerly imported vaſt quantities of prints, we now ſupply all Europe, and import very few. Even for the decoration of our books we were formerly obliged to apply to ſtrangers: but Heath has added a taſte to that department of art unknown to former engravers in the hiſtorical line. Among the topographical publications, thoſe prints that accompany the "Beauties of England and Wales" muſt be highly intereſting for taſte and beauty.

In the beginning of the laſt century, the writers on the continent amuſed themſelves in endeavouring to aſſign a cauſe for the dulneſs of us iſlanders in not having produced one hiſtorical painter. Our northern latitude, being involved in fogs, was among the reaſons aſſigned: but the cauſe of ſuch abſurd inquiries has ceaſed, and the mental capacity of Britons no one will now dare to queſtion.

The conſequence of our nation and the arts appear to have advanced together. The firſt is evinced in our colonial poſſeſſions; and if we go back to the time of Henry VIII., we ſhall eaſily diſcover the ſtate of commerce and the comfortleſs ſituation of ſociety compared with the preſent. Hollin-

ſhed obſerves that chimneys were a novelty, as were pewter ornaments for the table. Straw formed the bed, and a good hard block of wood the pillow. Then was the dawn of the arts. Since which time they have been advancing, and are now, thank God! matured into a glorious mid-day, under the auſpices of his preſent majeſty.

It is impoſſible to ſpeak of the arts without expreſſing our gratitude towards their great patron; and were his name to flouriſh in no other way, that of George III. will be ſacred to poſterity with thoſe of Leo, Julius, and all ſuch as have a claim on eternity, as their protectors. His majeſty has done for the arts what no monarch of this nation ever did before: he has given, by his patronage, a turn to the national taſte highly beneficial to the profeſſion, which the public are bound to ſupport by a liberal and fair encouragement. With reſpect to the mere act of buying, we are bound to conſider his majeſty in the light of a private gentleman, who regulates his expenditure according to his income: and we ought to thank God it is ſo.

Holbein had not taſte enough to change the groteſque faſhions of the court of Henry VIII. He brought about a revolution in architecture; but he introduced a mungrel ſtyle, inferior to the Gothic of that period. Zuccaro was in England in the time of Elizabeth; and during that long reign we find little improvement in architecture, dreſs, or in the general circle of elegancies. It was a court of intrigue and vanity. In the reign of James I. Van Somer and Cornelius Janſon paved the way for Van Dyck—an epoch of taſte: but this appears to have been confined to the court and a few noble collectors; and the troubles of Charles his ſucceſſor prevented his giving them a more general influence. His reign ſtands high in the hiſtory of architecture, from having produced Inigo Jones. Under Lely taſte ſunk into Indian gowns and flowing perukes; till faſhion became a monſter in the time of Kneller, and appeared in buckram coats, ſquare-toed ſhoes, and diſproportioned head-dreſſes in the ladies. This ſtyle of dreſs prevailed till within theſe few years, when good ſenſe and a more juſt taſte broke through the buckram and whalebone, and produced the preſent eaſy and elegant mode of attire; which may be ſaid to mark a point of national excellence. Reynolds contributed much to this change; his whole life was a ſtruggle with the hydra faſhion, as his works evince.

The above ſtatement will be found not to apply only to the article of dreſs, but to extend to every department. Let us, for inſtance, from the period of Henry VIII. examine ſhip-

ſhip-building, civil architecture, our furniture, plate, &c. &c., and we ſhall find them to have nearly improved together, or to have fluctuated as the taſte for *deſſin* prevailed, till the patronage beſtowed by his preſent majeſty, by exciting a general love for the arts, improved the national taſte to its preſent great and highly reſpectable ſtate.

Before we diſmiſs the preſent eſſay we ſhall endeavour to point out ſome of the advantages that reſult from the practice of drawing, to thoſe who do not make a profeſſion of it. Many muſt be obvious from the former part of this paper. To every gentleman who travels, it is abſolutely neceſſary; for, independently of its teaching him to ſee accurately, the curious and ever-reſtleſs eye of the artiſt comprehends more at one view than the common obſerver will notice in an age. The volume of nature is laid open to him; his attention is directed to the vaſt and minute; men and manners are not concealed from his view, and his imagination clings to perfection with ineffable delight.

It is not too much to ſay, that drawing opens the mind more than years devoted to the acquiring of languages, or the mere learning of words: it teaches to think. The artiſt is a true logician: not content with producing effects, he is ever inquiring after cauſes founded on a viſible demonſtration, to exhibit them in his works.

We muſt not rank it among the leaſt of the advantages reſulting from the practice of the arts, that it enures the reflecting mind to the moſt enticing ſort of logic. The practice of reaſoning upon objects in themſelves agreeable tends to produce ſuch a habit, and habit ſtrengthens the reaſoning faculties. Beſides, while the mind is engaged in obtaining knowledge, we eſcape the inſipidity and indifference connected with the tedioufneſs of inactivity. Hope attends labour; a bleſſing unknown to thoſe who live lazily on the toil of others. The ſenſualiſt imagines he enjoys the world becauſe he eats and drinks, and runs about upon it; but to enjoy it truly, is to be ſenſible of its greatneſs and beauty.

Independently of keeping the mind employed, the arts contribute to harmonize the temper; and the power of drawing brings with it ſo much mental enjoyment, that youth, in order to be occupied, is not tempted to precipitate into the ruinous and deſtructive vices of gaming and drinking. It defends us in the meridian of life from the wild ſchemes of ambition, and in old age it becomes a ſure ſhield againſt avarice. Shenſtone obſerves, "Wherever there is a want of taſte, we generally obſerve a love of money and cunning."

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The influence it has on our moral conduct is, perhaps, one of the greateſt recommendations for the ſtudy of the arts. No one can meditate on the order obſervable in nature, and not reduce his conduct to a ſimilar ſtandard of regularity. To have a juſt reliſh for what is elegant and proper in painting, ſculpture, or architecture, muſt be a fine preparation for true notions relative to character and behaviour. Should ſuch a one be overpowered by paſſion, or ſwerve from his duty, we need not fear but he will return on the firſt reflection, and with a redoubled reſolution not to err a ſecond time: for he cannot but obſerve, that the well-being of nature, as well as of the individual, depends on regularity and order; and that a diſregard of the ſocial virtues will ever be accompanied with ſhame and remorſe. Paſſion is a whirlwind, that ſhakes the human frame, as the convulſions of an earthquake diſorder that of nature.

Every Briton that travels ſhould propoſe to himſelf pleaſure and advantage, and his inquiry ſhould enable him to add to the national ſtock of knowledge; for it cannot be ſaid that he travels to enjoy the advantage of a better government, or becauſe other nations have a greater commerce. Hence, then, it muſt be for arts and learning. And how is he to become acquainted with the former without a knowledge in painting, ſculpture, and architecture, any more than he could with the latter, without a knowledge in the languages of the countries he may have occaſion to paſs through? Lord Bacon ſays: "Travel, in the younger ſort, is a part of education; in the elder, a part of experience. He that travelleth into a country before he hath ſome entrance into the language, goeth to ſchool and not to travel." The ſame may be ſaid of thoſe who travel before they have obtained a knowledge in the polite arts. How many noble works of architecture did lord Burlington bequeath to his country! They remain monuments of national taſte, highly honourable to his memory. Let us be permitted to mention the honour the arts at preſent derive from the maſterly productions of the earl of Aylesford, ſir G. Beaumont, ſir R. Hoare, W. Scope, eſq. of Caſtle-comb; captain Lewis, of the royal navy; capt. Mordaunt, and many others, whoſe works will ever rank among the firſt productions of the pencil. Lord Warwick is ſaid to poſſeſs the true poetic ſpirit for compoſing heroic landſcape. While we are recommending to gentlemen to learn to draw, it muſt not be underſtood that we wiſh to deprive the ladies of the pleaſure and advantage that muſt reſult from their practiſing an art that ſtands, perhaps, before all others for

improving

improving our tafte, particularly in fuch things as are connected with decoration.

Though we recommend learning to draw thus generally, we muft fay it requires the utmoft caution in the choice of a mafter; for, fhould his abilities be confined, or his tafte depraved, there is great danger of the poifon being conveyed to the pupil: and if, in the end, his better underftanding rife fuperior to the evil, he will, unfortunately, have much to unlearn. Above all, if he be arrived at an age to difcriminate, objects worthy attention fhould be fet as examples of imitation; he fhould not be amufed and his time wafted with gew-gaws and trafh beneath the dignity and attention of rational beings.

Every one is acquainted with the progrefs of what may be termed common or fchool education. The mafters begin teaching the letters, and then proceed to fyllables, which are joined into fentences: but the ultimate end is, compofing themes to call forth the power of invention, and convey a more exquifite idea of the language. Exactly fo fhould be the progrefs in teaching drawing. If the knowledge to be obtained be the human figure, we begin with parts; as eyes, nofes, heads, hands, &c., which is the A B C. This, of courfe, leads to the whole figure, which may be compared to fpelling; that naturally conducts to the round, or drawing from plaifter cafts; then from the life; and ultimately to compofition. Should landfcape be the purfuit, the progrefs is precifely the fame. We begin with parts or fingle objects; as trees, bridges, cottages, caftles, &c. Here again is the alphabet. This we too quit to copy wholes, or a combination of objects; and in the end we apply to nature, which fets us free from our mafter. Then we muft improve by our own activity; and, like the bee, cull the honey from every flower. As much of our fuccefs depends on the abilities of the mafter, the greateft care fhould be obferved in the choice. He is but as a crutch to the lame; but we ought to make ourfelves fure it is found, and without flaw or fhake; that is, as far as our judgment will permit, or the opinion of friends direct.

He who afpires to a knowledge in the fine arts can only hope to fucceed by turning his attention to the fenfitive part of nature, particularly by an inquiry after fuch objects as are naturally agreeable, or the contrary: alfo fuch as are grand or mean, proper or improper. This is the only foundation of a juft and rational tafte, and, like morals, may be cultivated to a high degree of refinement. The fine arts, where the feelings only are concerned, will pleafe, from their novelty,

velty, in the prime of life; but the delight will ceafe in a more advanced period, when the fervour of the imagination goes off. On the contrary, where we are governed by juft principles and a thorough knowledge, they will afford fcope for fancy as well as judgment, they will grow into a favourite entertainment, and their vigour will prevail as ftrong in the evening as in the morning of life. This only can make the arts truly delightful. It is not a few technical phrafes, picked up from profeffional men, which may enable one to babble like a parrot, that can at any time pleafe or be pleafing. Science is a coy lady, and will not grant her favours without being long courted. But, fhould we afpire to no higher character than that of the mere critic, a fmall ftock of information will fuffice; and practice will increafe confidence where there is nothing to lofe. Criticifm is a lady of eafy accefs: the want of meaning fhe fupplies with words; and the want of knowledge is recompenfed with cunning. She flatters all; and thofe whom nature has made weak, or idlenefs keeps ignorant, may feed their vanity at her fhrine.

XXXIV. *On the Differences which exift between the Heads of the Mammoth and Elephant.* By REMBRANDT PEALE, *Efq.**

THE drawings which accompany this (fee Plate V.) are intended to explain the differences between the head of the mammoth and that of the elephant. The teeth form the moft ftriking character: thofe of the elephant are exclufively graminivorous, and confequently diftinguifhed from thofe of the mammoth, which were intended for animal food of fome kind, and not improbably fhell-fifh, on the fuppofition that the animal was amphibious †: and this may account for the peculiar form and pofition of the tufks. On examining the head of the elephant, it will appear that the fockets for the tufks at A are fituated, with refpect to the condyle of the neck at B, nearly in an angle of 45 degrees; fo that the tufks, which have but little curve, are directed downwards and forwards, and may be with eafe employed offenfively and defenfively. On the other hand, it will be obferved that in the mammoth the focket A is nearly on a horizontal line with the condyle B; and therefore the tufks, which are femicircular, could never have been elevated in the air, pointing

* Communicated by the Author.

† See the former number, p. 162—169 of the prefent volume.

backwards,

backwards, but muſt have been as repreſented in the figure, the points thrown out by the ſpiral twiſt on each ſide:—in this poſition they might have anſwered in ſtriking down ſmall animals, or in detaching ſhell-fiſh from the bottoms of rivers, or even in aſcending the banks.

In the elephant the orbit of the eye is ſituated at C, whereas in the correſponding part at C in the mammoth is a large maſs of bone, ſo that the eye muſt have been elſewhere: to aſcertain where, we muſt wait until we receive the cranium lately diſcovered on the Ohio. The cheek of the elephant is formed of two bones; but in the mammoth, beſides other variations, there is but one bone. The whole figure of the under-jaw differs moſt remarkably; firſt in the length of the condyles or arms from E to B: in the mammoth it is ſhort and angular; but in the elephant D E B forms a ſemicircular line, and at D it is long and pointed.

This ſhort reference is ſufficient to direct the attention of thoſe who wiſh to examine them more critically; when they may remark ſeveral other characters ſufficiently intereſting.

XXXV. *On the Hydrometer.* By WILLIAM SPEER, *Eſq. Superviſor and Aſſayer of Spirits in the Port of Dublin.*

[Concluded from p. 162.]

I SHALL now proceed to explain Mr. Gilpin's tables, in order to demonſtrate their uſe, and the uſe of my additional columns. The firſt I cannot do better than in the words of Sir Charles Blagden himſelf:

"Tables for reducing the quantities by weight, in any mixture of pure ſpirit and water, to thoſe by meaſure; and for determining the proportion, by meaſure, of each of the two ſubſtances in ſuch mixtures, by Mr. George Gilpin, clerk to the Royal Society, communicated by Sir Charles Blagden:

"Theſe tables are founded on the experiments, of which the reſults were given in the Report and Supplementary Report on the beſt Method of proportioning the Exciſe on Spirituous Liquors. They are computed for every degree of heat, from 30° to 80°, and for the addition or ſubtraction of every one part in a hundred of water or ſpirit; but as the experiments themſelves were made only to every fifth degree of heat, and every five in the hundred of water or ſpirit, the intermediate places are filled up by interpolation in the uſual manner, with allowance for ſecond differences.

"Every table confifts of eight columns, and there are two tables for every degree of heat. In the firft column of the *firft* of the two tables are given the proportions of fpirit and water by weight, 100 parts of fpirit being taken as the conftant number, to which additions are made fucceffively of one part of water, from 1 to 99 inclufively: the firft column in the fecond table has 100 parts of water for the conftant number, with the parts of fpirit decreafing fucceffively by unity, from 100 to 1 inclufively.

"It muft be obferved, that each of thefe tables, occupying one page, is divided in the middle for adapting it more conveniently to the fize of the paper; but the whole of each page is to be confidered as one continued table. The fecond column of all the tables gives the fpecific gravities of the correfponding mixtures of fpirit and water in the firft column, taken from the table of fpecific gravities in the Supplementary Report, the intermediate fpaces being filled up by interpolation. In the third column, 100 parts by meafure of pure fpirit, at the temperature marked at the top of every feparate table, is affumed as the conftant ftandard number, to which the refpective quantities of water by meafure, at the fame temperature, are to be proportioned in the next column.

"The fourth column, therefore, contains the proportion of water, by meafure, to 100 meafures of fpirit, anfwering to the proportions by weight in the fame horizontal line of the firft column. The fifth column fhows the number of parts which the quantities of fpirit and water, contained in the third and fourth columns, would meafure when the mixture has been completed; that is, the bulk of the whole mixture after the concentration or mutual penetration has fully taken place. The fixth column, deduced from the three preceding ones, gives the effects of that concentration, or how much fmaller the volume of the whole mixture is, than it would be if there was no fuch principle as the mutual penetration. The feventh column fhows the quantity of pure fpirit by meafure, at the temperature in the table, contained in an hundred meafures of the mixture laid down in the fifth column."

From this account it will be feen, that every mixture of pure fpirit and water poffible to be made, is analyfed fo clearly at every temperature, as to render it a matter of no great difficulty to demonftrate, at a given temperature, all the gradations of ftrength which the hydrometer fhould indicate. The mode in which this has been done I fhall now explain.

The table which Mr. Gilpin has calculated for the temperature of 55, is that which I have chofen, conceiving it,

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for feveral reafons, to be the moft convenient. And as a reference to it becomes neceffary, I have annexed this, with the additional columns to it, by which the hydrometer indications of ftrength are regularly deduced from the fpecific gravity of the fpirit at this temperature *.

In order to explain the manner in which I have calculated thefe additional columns, I conceive the eafieft mode will be by an example.

It being underftood by the trade that the fpecific gravity of proof fpirit at this temperature (55) is 922, I look at the table for this fpecific gravity, and I find that it is a mixture of pure fpirit and water, in the following proportions, viz. 100 parts of the former to 81 of the latter (both by weight), but that by meafure it is made by mixing 100 gallons of pure fpirit with 66 gallons 99 parts of water. I then find that the diminution of bulk, by penetration, on the mixture by meafure, (that by weight being unneceffary to attend to in bringing out the refult,) is 4 gallons 57 parts, as, inftead of producing 166 gallons 99 parts, there will be only 162 gallons 42 parts. I find next, that this mixture contains per cent. of pure fpirit 61 gallons 57 parts.

Thefe being the proportions in the ftandard of proof, to which every other gradation of ftrength is relative, the Rule of Three demonftrates this relation in a manner requiring to be explained by another example. Suppofe a fpirituous liquor is produced to afcertain the hydrometer indication; on weighing it in a phial adapted to this purpofe, I find that at the temperature of 55, its fpecific gravity is 848; by looking into the table I perceive that this contains per cent. 93·18 of pure fpirit. I then try how much more than proof this is by fubtracting 61·57 (the quantity which proof contains), and I find that this has a redundance of pure fpirit, amounting to 31·61.

Therefore, as 100 gallons of pure fpirit require 66 gallons 99 parts of water to reduce it to proof, the redundant 31·61 will require 21·17. Add thefe, and from the amount 52·78 the diminution of bulk by penetration is to be deducted, which, by the ratio in proof fpirit being 1·44, the refult finally comes out that this fpirit is 51 gallons and 34 parts (about one-third) over hydrometer proof. The under proofs require lefs calculation, the excefs of water per cent. over the proportion which proof contains being all that is required.

* It may perhaps be neceffary to obferve here, that a reference to this table is not required in the ufe of the hydrometer I have conftructed, further than to try whether it be correct.

 Thefe

These examples are, I hope, sufficient to explain this table. The uses to which it is applicable, are, that *as it affords first an unequivocal standard for every gradation of strength,* an hydrometer can be graduated on a certain principle; and, secondly, the errors of those that are graduated otherwise may be discovered by it, and we shall no longer be obliged to rely on a mere assertion, that the instrument is correct, nothing more being required than to compare the specific gravity of the spirit with the indication of strength which it has demonstrated.

On considering how far it might be practicable to simplify the hydrometer, I perceived that the makers of these instruments had fallen into two errors, which had very considerably increased the necessity for those complex additions with which they are incumbered.

First, conceiving that the instrument was to be valued in proportion as it was capable of making *minute* discriminations, (or of its sensibility as it is called,) they have, by attempts to increase this beyond those limits required either in revenue or in commerce, destroyed its simplicity.

In the construction of this instrument, the proportion of the stem to the ball is an important consideration: if the former be too large, the instrument will not be sufficiently sensible; and should it, on the contrary, be too small, the number of gradations of strength it is capable of indicating will proportionably be diminished.

Those who have constructed most of the hydrometers now in use, have run into the latter error; the stem being diminished to a size which rendered it necessary to have recourse to complex additions to supply the place of this injudicious and unnecessary waste of the simple and proper power of the instrument.

From a great variety of experiments to ascertain the proper proportion between the ball and stem, I was finally satisfied that the latter would admit of such enlargement as to be rendered capable of measuring upwards of 66 gradations or per centages of strength, without any weight; and this so clearly and distinctly, as to convince me that its sensibility and accuracy were still fully sufficient.

The second error alluded to has arisen from an attempt to extend the power of the instrument beyond those limits, which, with propriety, and consistently with its simplicity, could be effected.

An hydrometer being a counterpoise to ascertain the weight of a spirituous liquor, may, with propriety, be compared to a

pair of ſcales *, of which there are various *ſizes* and *deſcriptions*, to anſwer *different purpoſes*, by which means their ſimplicity is uniformly preſerved.

On the contrary, it has erroneouſly been conceived, that an hydrometer would be imperfect that did not, *by one means or another*, aſcertain the ſpecific gravity of all liquids at their various temperatures: the ſimple power of every inſtrument of this kind being confined within certain limits, this could not be effected without additional complications of various kinds to thoſe which were added, to increaſe its ſenſibility, ſome of which are certainly ingenious, but, I conceive, highly unfit for the purpoſe of revenue.

Should this ingenuity be exerciſed on a pair of ſcales, which it would be proper to uſe in weighing a portion of eight or ten pounds, and by complex additions render them ſufficiently ſenſible to aſcertain a few grains or fraction of a grain, or ſo extended in their power as to weigh 100 pounds, is it not evident that the ſimplicity of the balance, which is its great recommendation, would be deſtroyed?

That which led to the conſtruction which I finally fixed on, was firſt a *quadrangular ſtem*, from which I had four temperatures, viz. 35, 45, 55, and 65; and the intermediate degrees I managed with four ſmall weights on the top of the ſtem, each ſerving for two degrees of temperature. The inſtrument having been graduated with theſe on, if the temperature ſhould be *two* degrees higher than the ſcale, I removed one weight, in order to lighten the inſtrument equal to the decreaſe of ſpecific gravity; if *four* degrees, I removed two weights; if *ſix* degrees, I removed three weights; and if *eight* degrees, I removed the fourth; and two degrees more brought me to a new ſcale, or ſide of the ſtem: by this means the inſtrument would accord with the variations ariſing from temperature, ſo far as at moſt to be but one degree different from it. It was adjuſted at every tenth degree of temperature.

This was evidently a conſiderable progreſs towards the object I was in purſuit of, as it not only remedied the great defect of inattention to temperature which took place in the Iriſh hydrometer, but, in a great meaſure, the various defects of the Engliſh revenue hydrometer, as, notwithſtanding the weights were reduced from 36 to 4, it accorded nearly with the

* The name of the inſtrument, which in ſtrictneſs ſhould be areometer, (hydrometer being an inſtrument for weighing water), demonſtrates this to be the principle on which it acts; therefore in France it is called *peſe liqueur*, and by ſome Engliſh writers, a water-poiſe.

the various temperatures, and indicated 66 gradations of ſtrength. I perceived, therefore, that the principle would anſwer, but that it could be improved ſtill further; and after various efforts I at length fixed on that conſtruction, of which I ſhall now beg leave to give a deſcription.

This new hydrometer is made of hard braſs: the ball is ſhaped in the form of a pear, being nearly two inches in diameter at its greateſt dimenſion, and two inches and a quarter in length: the lower ſtem meaſures one inch and a half, and is in ſhape a priſm, each ſide meaſuring one-eighth of an inch: to the lower end of this a round weight is fixed, the diameter of which is ſeven-eighths of an inch. The upper ſtem is in length five inches and a half, and is an octagon, each ſide being ſomewhat leſs than an eighth of an inch wide: each of theſe ſides is graduated for a temperature engraved on the top, the loweſt being 35, the ſecond 40, and ſo increaſing by five until it reaches 70. The zero, or proof point, is marked Θ, and the gradations of ſtrength (numbered at every fourth) amount to ſixty-ſix, and thoſe ſo clearly diſtinct, that at the over-proofs they will admit of a ſub-diviſion, and by that means indicate a half per cent. Theſe diviſions are not at equal diſtances; an error which takes place in the preſent Iriſh and ſeveral of the old hydrometers, but widen in proportion as the ſpecific gravity of the ſpirit diminiſhes; and, being graduated with ſpirits of known ſtrengths at every four per cent., the intermediate per centages are adjuſted by interpolation.

To prevent any error which might ariſe from taking the indication of ſtrength from the wrong ſide of the ſtem, an index is applied on the top of it, with an opening to ſhow the figures which point out the temperature. This index, which applies *merely* to the purpoſe here mentioned, may be removed lower to any part of the ſtem, but above the ſurface of the liquor, without affecting the accuracy of the inſtrument, as neither its weight nor dimenſion is changed; and being of a different colour from the ſtem (ſanguined ſteel) it forms a contraſt with it, and, as it were, points to the indication ſought for, by which every danger of error in this reſpect is removed.

Although this is the only uſe of the index, when the temperature ſhall be found one of thoſe eight marked on the ſtem, yet it is neceſſary that the inſtrument ſhall accord with the four intermediate degrees between each of the adjoining ſides: for this purpoſe one of two other indexes of different weights are occaſionally ſubſtituted for the firſt one, in order to lighten

the

the inftrument fo as to accord with the decreafe of gravity which takes place in the fpirit by the increafe of temperature. Therefore the manner of ufing the inftrument is as follows:

Suppofing the temperature to be 50, nothing further is required but to place the index No. 1 (each being marked fo as eafily to be diftinguifhed) on the fide marked 50, and immerfe the inftrument, which at once fhows the ftrength. Should the temperature be 51 or 52, inftead of index No. 1, ufe that marked No. 2: fhould it be 53 or 54, ufe index No. 3: the inftrument having been adjufted with thefe two auxiliary indexes, in the one cafe at a temperature of $51\frac{1}{2}$, and in the other $53\frac{1}{2}$, thefe four intermediate temperatures are fo accorded to, as to be either the actual one, or within *half a degree* of it. And they apply in all cafes, to the four intermediate degrees of temperature, and no other appendage required to enable the inftrument, in this plain and fimple manner, to meafure fixty-fix gradations of ftrength with an accuracy which, it is prefumed, is fully fufficient for either revenue or commerce *. No weight requiring different immerfions to find out that which is the proper one; no temperature omitted to create doubts, or falfe indications of ftrength; no fraction in the per centage to operate either againft the revenue or the merchant; no gradation of ftrength left unafcertained or determined by conjecture; no doubt remaining as to the correct ftrength of all the various gradations; and no fecond infpection and fubfequent combination to be made, requiring the aid of, and liable to the errors of, a fliding rule.

The following is a table for graduating hydrometers on a certain and invariable principle, fhowing from the fpecific gravity of the fpirit at the temperature 55, what the hydrometer indication of ftrength fhould be of every poffible mixture of pure fpirit (or alcohol) and water, from the former down to proof fpirit.—N. B. This table is calculated on the *fuppofition* that the ftandard of proof is 922, temperature 55.

* Even this half degree of temperature may be obtained by holding the jar containing the fpirit for a few moments in the hand.

Table

I. Spirit & water by weight.	II. Specific gravity at 55.	III. Spirit by measure	IV. Water by measure	V. Bulk of mixture	VI. Diminution of bulk, or concentration.	VII. Quantity of pure spirit, per cent.	VIII. Pure spirit per cent. redundant.	IX. Water to reduce redund. spirit to proof	X. Diminution of bulk on red. spirit & water	XI. Per Cent over Hydrometer proof.
Sp. + W.										
100 + 0	,82736	100		100,00		100,00	38,43	25,74	1,75	62,42
1	,82967		0,83	100,72	0,11	99,29	37,72	25,26	1,72	61,26
2	,83192		1,65	101,44	0,21	98,58	37,01	24,79	1,69	60,11
3	,83412		2,48	102,16	0,32	97,88	36,31	24,32	1,65	58,98
4	,83626		3,31	102,89	0,42	97,19	35,62	23,86	1,62	57,86
100 + 5	,83834		4,93	103,62	0,51	96,50	34,03	23,39	1,59	56,73
6	,84037		4,16	104,36	0,60	95,82	34,25	22,94	1,56	55,63
7	,84235		5,79	105,10	0,69	95,15	33,58	22,49	1,53	54,54
8	,84429		6,62	105,84	0,78	94,49	32,92	22,05	1,50	53,47
9	,84618		7,44	106,58	0,86	93,83	32,26	21,61	1,47	52,40
100 + 10	,84802		8,27	107,32	0.95	93,18	31,61	21,17	1,44	51,34
11	,84982		9.10	108,07	1,03	92,54	30,97	20,74	1,41	50,30
12	,85158		9,92	108,81	1,11	91,90	30,33	20,31	1,38	49,26
13	,85330		10,75	109,56	1,19	91,27	29,70	19,89	1,35	48,26
14	,85499		11,58	110,32	1,26	90.65	29,08	19,47	1,32	47,23
100 + 15	,85664		12,41	111,07	1,34	90,03	28,46	19,06	1,30	46,22
16	,85825		13,23	111,82	1,41	89,43	27,86	18,66	1,27	45,25
17	,85984		14,06	112,58	1,48	88,83	27,26	18,26	1,24	44,28
18	,86139		14,89	113,34	1,55	88,23	26,66	17,85	1,21	43,30
19	,86292		15,71	114,09	1,62	87,64	26,07	17,46	1,19	42,34
100 + 20	,86441		16,54	114,86	1,68	87,06	25,49	17,07	1,16	41,40
21	,86588		17,37	115,62	1,75	86,49	24,92	16,69	1,13	40,48
22	,86732		18,19	116,38	1,81	85,93	24,36	16,31	1,11	39,56
23	,86874		19,02	117,14	1,88	85,37	23,80	15,94	1,08	38,66
24	,87013		19,85	117,90	1,95	84,82	23,25	15,57	1,06	37,76
100 25	,87150		20,68	118,67	2,01	84,27	22,70	15,20	1,03	36,87
26	,87284		21,50	119,43	2,07	83,73	22,16	14,84	1,01	35,99
27	,87415		22,33	120,20	2,13	83,19	21,62	14,48	1,98	35,12
28	,87544	100	23,16	120,97	2,19	82,66	21,09	14,12	0,96	34,25
29	,87671		23,98	121,74	2,24	82,14	20,57	13,77	0,93	33,41
100 + 30	,87796		24,81	122,51	2,30	81,63	20,06	13,43	0,91	32,58
31	,87919		25,64	123,28	2,36	81,12	19,55	13,09	0,89	31,75
32	,88040		26,46	124,05	2,41	80,62	19,06	12,76	0,87	30,94
33	,88160		27.29	124,82	2,47	80,12	18,55	12,42	0,84	30,13
34	,88277		28,12	125,59	2,53	79,63	18,06	12,09	0,82	29,33
100 + 35	,88393		28,95	126,36	2,59	79,14	17,57	11,77	0,80	28,54
63	,88507		29,77	127,13	2.64	78,66	17,09	11,44	0,78	27,75
37	,88619		30,60	127,90	2,70	78,18	16,61	11,12	0,76	26,97
38	,88729		31,43	128,68	2,75	77,71	16,14	10,81	0,74	26,21
39	,88838		32,25	129,45	2,80	77,25	15,68	10,50	0,71	25,47
100 + 40	,88945		33,08	130,23	2,85	76,79	15,22	10,19	0,69	24,72
41	,89051		33,91	131,00	2,91	76,33	14,76	9,88	0,67	23,97
42	,89155		34,74	131,77	2,97	75,88	14,31	9,58	0,65	23,24
43	,89258		35,56	132,55	3,01	75,44	13,88	9,29	0,63	22,54
44	,89359		36,39	133,33	3,06	75,00	13,43	8,09	0,61	21,81

I. Spirit & water by weight.	II. Specific gravity at 55°.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk or concentration.	VII. Quantity of pure spirit per cent.	VIII. Pure spirit per cent. redundant.	IX. Water to reduce redund. spirit to proof	X. Diminution of bulk on red. spirit & water.	XI. Per cent. over Hydrometer proof.
Sp. + W.										
100 + 45	,89458		37,22	134,11	3,11	74,57	13,00	8,70	0,59	21,11
46	,89556		38,04	134,88	3,16	74,14	12,57	8,42	0,57	20,42
47	,89653		38,87	135,66	3,21	73,71	12,14	8,13	0,55	19,72
48	,89748		39,70	136.44	3,26	73,29	11,72	7,85	0,53	19,04
49	,89841		40,52	137.22	3,30	72,88	11,31	7,57	0,51	18,37
100 + 50	,89933		41,35	138,00	3,35	72,47	10,90	7,30	0,49	17,71
51	,90023		42,18	138,78	3,40	72,06	10,49	7,02	0,47	17,04
52	,90111		43,01	139,56	3,45	71,65	10,08	6,75	0,46	16,37
53	,90198		43,83	140,34	3,49	71,25	9,68	6,48	0,44	15.72
54	,90283		44.66	141,13	3,55	70,86	9,29	6,22	0,42	15,09
100 + 55	,90367		45,49	141,91	3,58	70,47	8,90	5,96	0,40	14,46
56	,90450	100	46,31	142,70	3,61	70,08	8,51	5,70	0,38	13,83
57	,90531		47,14	143,48	3,66	69,69	8,12	5,43	0,37	13,18
58	,90611		47,97	144,27	3,70	69,31	7,74	5,18	0,35	12,57
59	,90690		48,79	145,05	3,74	68,94	7,37	4,93	0,33	11,97
100 + 60	,90768		49,62	145,84	3,78	68,57	7,00	4,68	0,31	11,37
61	,90845		50,45	146,63	3,82	68,20	6,63	4,44	0,30	10,77
62	,90921		51,28	147,42	3,86	67,83	6,26	4,19	0,28	10,17
63	,90996		52,10	148,20	3'90	67,48	5,91	3.95	0,26	9,60
64	,91070		52,93	148,99	3,94	67,12	5,55	3,71	0,25	9,01
100 + 65	,91144		53,76	149,78	3,98	66,77	5,20	3,48	0,23	8,45
66	,91217		54.58	150,57	4,01	66,42	4,85	3,24	0,22	7,77
67	,91289		55,41	151,35	4.06	66,07	4,50	3,01	0,20	7,31
68	,91361		56,24	152,14	4,10	65,73	4,16	2,78	0,18	6,76
69	,91432		57,07	152,93	4,14	65,39	3,82	2,55	0,17	6,20
100 + 70	,91502		57,89	153,71	4,18	65,06	3,49	2,33	0,15	5,67
71	,91571		58,72	154,50	4,22	64,73	3,16	2.11	0,14	5,13
72	,91639		59,55	155.29	4,26	64,40	2,83	1,89	0,12	4,60
73	,91706		60,37	156,08	4,29	64,07	2,50	1,67	0,11	4,06
74	,91772		61,20	156,87	4,33	63,75	2,18	1,45	0,08	3,55
100 + 75	,91837		62,03	157,66	4,37	63,43	1,86	1,24	0,08	3,02
76	,91901		62,85	158,45	4,40	63,11	1,54	1,03	0,07	2,50
77	,91963		63,68	159,24	4,44	62,80	1,23	0,82	0,05	2,00
78	,92024		64,51	160,04	4,47	62,49	0,92	0,61	0,04	1,49
79	,92085		65.34	160,83	4,51	62,18	0,61	0,40	0,02	0,99
100 + 80	,92145		66,16	161,62	4,54	61,87	0,24	0,16	0,01	0,39
81	,92205		66,99	162,42	4,57	61,57	0,00	0,00	0,00	Proof

N. B. When this Table ſhall be finally calculated, the fractions in the ſecond and laſt column are to be rendered into whole numbers.

XXXVI. *Me-*

XXXVI. *Memoir on the Supply and Application of the Blow-pipe.* *By Mr.* ROBERT HARE *jun. Member of the Chemical Society of Philadelphia* *.

THE blow-pipe is, on many occaſions, an uſeful inſtrument to the artiſt and philoſopher. By the former it is uſed, for the purpoſe of enamelling, to ſoften or ſolder ſmall pieces of metal, and for the fabrication of glaſs inſtruments: while the latter can, by means of it, in a few minutes, ſubject ſmall portions of any ſubſtance to intenſe heat; and is thereby enabled to judge of the advantage to be gained, and the method to be purſued, in operations on a larger ſcale. The celebrated Bergman has amply diſplayed the utility of this inſtrument in docimaſtic operations; and with the perfection of the docimaſtic art the improvement of metallurgy is intimately connected. It is by means of the blow-pipe that glaſs tubes are moſt conveniently expoſed to the heat neceſſary to mould them into the many forms occaſionally required for philoſophical purpoſes; and by the various application of tubes thus moulded, ingenuity is often enabled to ſurmount the want of apparatus, which is the greateſt obſtacle to the attainment of ſkill in experimental philoſophy.

To all the purpoſes which I have mentioned the blow-pipe is fully adequate, when properly ſupplied with air, and applied to a proper flame: but it appears that the means which have hitherto been employed to accompliſh thoſe ends are all faulty.

The moſt general method is that of ſupplying this inſtrument with the breath. In addition to the well-known difficulty of keeping up a conſtant emiſſion of air during reſpiration, and its injurious effect on the lungs †; it may be remarked, that as the breath is deprived of part of its pure air, is mixed with carbonic acid gas, and loaded with moiſture, it is not the moſt fit for combuſtion; and the obvious impoſſibility of ſupporting a flame with oxygen gas, by this method, is alſo worthy of conſideration.

Another way of ſupplying the blow-pipe with air, is that of affixing to it a ſmall pair of double bellows. A contrivance of this kind poſſeſſes obvious advantages over the mouth blow-pipe; but, owing to the pervious nature of the materials of which bellows are conſtructed, and the difficulty of

* Publiſhed by order of the Society.

† In conſequence of this, ſome artiſts have abandoned the uſe of the inſtrument.

making

making their valves air-tight, upwards of nine-tenths of the air drawn into them efcapes at other places than the proper aperture. A pair of bellows of this kind, belonging to an artift of this city, which were confidered as unufually air-tight, were found to difcharge the complement of their upper compartment in fix-fourths of a minute, when the orifice of the pipe was open; and in feven-fourths of a minute when it was clofed. Hence it appears, that fix-fevenths of the air injected into the upper compartment efcaped at other places than the proper aperture; and if to this lofs were added that fuftained by the lower compartment, the wafte would be found much greater. As in operating with thefe machines, it is neceffary conftantly to move the foot, the operator cannot leave his feat; and, in nice operations, the motion of his body is an inconvenience, if not a fource of failure. Bellows of this kind cannot be ufed for fupplying combuftion with oxygen gas; becaufe, as this air is only to be obtained by a chemical procefs, the fmalleft wafte of it is of ferious confequence; and as there is always a portion of air remaining in them, even when the boards are preffed as near to each other as the folding of the leather will permit, any fmall quantity of oxygen gas which might be drawn into them would be thereby contaminated.

It feems that the only inftrument hitherto ufed for the fupply of combuftion with oxygen gas, is the gafometer of the celebrated Lavoifier: but this machine, although admirably calculated for the purpofes of that great philofopher, is too unwieldy and expenfive for ordinary ufes.

Being fenfible of the advantage which would refult from the invention of a more perfect method of fupplying the blow-pipe with pure or atmofpheric air, I was induced to fearch for means of accomplifhing this object. Having obferved the cheapnefs, ftrength, and tightnefs, of coopers' veffels, I became defirous of forming an apparatus for my purpofe, by means of hydroftatic preffure exerted within them. I foon found that this could not be effected conveniently without the ufe of leather. Obliged to refort for affiftance to this material, I endeavoured to apply it in fuch manner, as to remedy the evils refulting from the ufe of it in the common kinds of bellows. The caufes of thefe evils appeared to be, the opening of the pores and joints of thefe inftruments by drynefs, and the tenfion to which they are fo frequently fubjected. I therefore determined to fubject the leather which I fhould ufe, to moifture and compreffion. In this I fucceeded, and derived the expected advantage from fuccefs. The refult of my

my attention to this fubject is the production of a machine, of which there follows an engraving and defcription.

When it was firft fhown to the gentlemen of the Chemical Society, fome of them beftowed on it the appellation of *gafometer*; but, as etymology does not authorize this name, it has been changed for that of *hydroftatic blow-pipe.*

Fig. 1. (fee plate VI.) is a perfpective engraving of the hydroftatic blow-pipe. Part of this figure is made tranfparent, that the internal conftruction of the machine may be underftood with the greater facility.

It confifts of a cafk A, whofe length is thirty-two, and whofe leaft diameter is eighteen inches. It is divided, by the partition B, into two apartments. The upper and external apartment B A, is in depth fourteen inches. The lower and internal apartment B C, is in depth fixteen inches; and contains a fheet and pipe of copper E E, D, which defcend into it nine inches, forming two equal compartments of that depth. The fheet and pipe of copper are foldered together and inferted into the partition B, as may be obferved at fig. 2; where B reprefents the partition, E E the fheet of copper, and D the pipe. The edges E E of the fheet were flid down into correfponding joints in the ftaves of the cafk until the partition attained its proper fituation. Coopers' flags were then paffed into the joints; and the hoops were driven on the cafk.

C F, fig. 1. is a pair of circular bellows. The bottom of the cafk ferves as a bottom for thefe bellows. In the centre of this bottom there is a hole, round which, at the diftance of one inch from its centre, is a circular rim of wood. On this is nailed a valve opening upwards, which may be obferved at B, fig. 3, where there is a tranfparent engraving of the bellows. Under the valve B may be obferved the hole, and circular rim of wood, over which it is nailed. C the top of the bellows, is a circular piece of wood, feven inches in diameter and two in thicknefs. In its centre there is a hole one inch and a half in diameter. Around this hole there is a circular rabbet, in which is nailed a valve, opening upwards. This valve, and the rabbet in which it is faftened, may be feen under the letter D, at the end of the rod. There is alfo in this top, at the diftance of one inch from its perimeter, a circular dove-tailed furrow filled with lead, E. The body of the bellows F F, is compofed of ftrong hofe-leather fo as to be water-tight. Before it was fixed to the other parts of the bellows its form was that of a hollow fruftum of a cone, of which the perpendicular and greateft diameter were each

each eight inches, and whofe leaft diameter was fix inches and a half. It was more eafily faftened to its appendages when of this conical form than if it had been cylindrical. At the protuberances FF, it is diftended by two iron rings, to which it is fewed faft.

FG, fig. 1, is an iron rod, by means of which the top of the bellows may be raifed or depreffed. It paffes up through the pipe D to the handle G, which is worked by the hand or with the foot by means of the pendent ftirrup. An enlarged view of this rod, and of the contrivance by which it is annexed to the top, may be feen at fig. 3; where GD reprefents the rod, and H, H, H, H, flat pieces of iron branching from it. Thefe are fixed to the circular rim KK in fuch a manner as to include the rim II, of the fame metal, which is fcrewed faft to the top of the bellows. Sufficient room is left to allow the pieces H, H, H, H, and the rim KK, to move round without rubbing againft the included rim II, or the top of the bellows.

A copper hood, with an opening in one fide, may be obferved at L, fig. 3. The rod GD is paffed through the centre of this hood, until the flat pieces of iron H, H, H, H, come in contact with the flat part of it. The hole in the centre is then luted. The hood may be feen in its proper fituation, at F, fig. 1.

HI, fig. 1, is a fuction-pipe half an inch in diameter. It paffes under the cafk in the direction of the dotted lines at C, and turns up into the hole in the bottom of the bellows. This hole, which is of fuch a fize as to fit the tapering end of the pipe, is feen at fig. 3, and has already been mentioned, together with a circular rim of wood, which, being nailed round it, prevents the end of the pipe from touching the valve. The fuction-pipe has a conical mouth at I, into which is inferted occafionally the pipe J, faftened to the hofe and fyphon K, L. The hofe is made of leather, diftended by hollow cylinders of tin half an inch in diameter and one inch in length. Thefe were coated with tar, after which the leather was fewed over them *.

Fig. 1, MNO, mno, are pipes of delivery, furnifhed with cocks at N, n, and conical mouths at O, o. Each of thefe pipes communicates with one of the compartments on each fide of the fheet and pipe EE, D.

In the partition B, may be obferved the pipe Y, furnifhed

* This hofe may be made very perfect by tarring, and covering it with leather a fecond time; the feams of the firft and fecond coverings being placed on oppofite fides. Flexible pipes thus prepared will be found ufeful for many other purpofes befides that here mentioned.

with a cock. Each end of this pipe communicates with one of the compartments above mentioned.

P is a table affixed to the cafk by means of irons, which are at pleafure flid into or out of ftaples. One of thefe irons, and its ftaples, may be feen near the letter Q. They are faftened to pieces of wood which run lengthwife under the table, and which are fo grooved as to fupport a block of wood which flides between them. Through this block paffes the fcrew S, which flides backward and forward in the opening TRV. The ftand TV, which may be obferved under the lamp, is loofely put on this fcrew, as a wheel is placed on its axletree. It rifes and falls with the fcrew; but is prevented from turning round with it, by the upright ftrip of wood T.

Having defcribed the conftruction of the hydroftatic blow-pipe, I proceed to an explanation of the principle and manner of its action, and to a detail of the ufes to which it may be applied.

Suppofe that as much water were poured into the cafk A, fig. 1, as would fill the lower apartment, and rife above the partition B, one or two inches. Let fig. 4 be a reprefentation of the cafk when fupplied with this neceffary quantity of water. When the machine is at reft, the top of the bellows, being loaded with lead, is depreffed as low as the folding of the leather will permit, and the fmall fpace which remains in confequence of this folding, between the top of the bellows and the bottom of the cafk, becomes filled with water, which leaks through the upper valve. Let the bellows be extended by depreffing the handle at *a*. The upper valve will fhut tight; and a quantity of water equal to the bulk, which the bellows will gain by extenfion, will rife through the pipe D, to the external apartment; and the weight of the atmofphere being removed from the top of the valve in the bottom of the cafk, the air will prefs through the fuction-pipe I H, lift this valve, and occupy the vacant fpace within the bellows. If the hand be then removed from the handle, the lead in the top of the bellows will again deprefs it, and the air drawn into them, being thereby compreffed, will force open the upper valve, and afcend. During its afcent it will receive a ftrong lateral tendency from the hood, which will make it pafs out at the open fide of the hood, into that compartment which is immediately over this opening; and as by turning the rod, this part of the hood may be brought under either compartment, fo the air may be thrown into either of them; and one of them being filled with one fpecies of gas, the other may be filled with another fpecies: nor can there be any danger of mixture; becaufe, as the pipe D is fhorter than

than the ſheet EE, any ſuperabundant quantity of air which may be thrown into either compartment will paſs up the pipe and eſcape.

In fig. 4, the bellows are repreſented as nearly depreſſed, and the air iſſuing from the open ſide of the hood into the compartment immediately over it, which is about half filled with air. The other compartment is repreſented as being completely full of that fluid. The water is repreſented in commotion, that the action of the machine may be ſtrongly marked; but the motion of this fluid is in reality ſo gentle, that the regularity of a blaſt is not thereby perceptibly affected.

If it be deſired to fill both compartments with one kind of air, without the trouble of turning the hood, by opening the cock of communication in the pipe Y, any air which may be thrown into either compartment will divide itſelf equally between both of them.

It muſt be obvious that the air in the compartments on each ſide of the ſheet and pipe of copper EE, D, fig. 4, is ſubject to hydroſtatic preſſure, and that of courſe it will paſs out at the pipes of delivery, unleſs ſtopt by the cocks. Theſe pipes are omitted in fig. 4, but have been already deſcribed, together with their cocks, at MNO, mno, fig. 1.

The leather and joints of the bellows are evidently ſubjected to the weight of a conſiderable column of water; but this preſſure, being external, tends to tighten them, and renders this part of the machine ſo perfect, that if the orifice of the ſuction-pipe be cloſed, it will be found impoſſible to raiſe the top of the bellows, without the immenſe force which would be neceſſary to produce a vacuum within them. This would not be the caſe if the ſmalleſt leakage took place.

It is now time to give an account of the purpoſes to which the hydroſtatic blow-pipe may be applied, and the manner of applying it to them.

This inſtrument may be employed to ſupply with atmoſpheric air a ſmall flame for the various purpoſes of the mouth blow-pipe. To effect this, it is only neceſſary to place a lamp or candle on the ſtand TV, which is upheld by the ſcrew S, fig. 1. By raiſing or lowering this ſcrew, or by ſliding backward or forward the block through which it paſſes, the ſtand may be ſo adjuſted, as that the ſtraight mouth-piece X will juſt enter the flame. The handle muſt then be worked until the blaſt obtains the proper ſtrength. This generally happens when the water has riſen above the partition B three or four inches. If it ſhould be raiſed higher,

 the

the blaſt may be regulated by turning the cock more or leſs at N.

When an operation is to be performed on a ſubject which cannot be held over the table; by fixing the ſmall hoſe and blow-pipe a b, fig. 7, into one of the conical mouths O, o, of the pipes of delivery, and, by placing a lamp or candle on the edge of the table, an operator may, with the ſubject in his hand, expoſe the proper ſpot to the flame. In this way glaſs matraſſes filled with liquors have been hermetically ſealed.

Nothing can be more ſteady than the ſtream of air emitted by this inſtrument. The falling off in preſſure, ariſing from the deſcent of the water, does not perceptibly affect the flame in a blaſt of ſix minutes duration; and, in the mean time, the handle may be depreſſed ſo gently, that the moſt ſtrict obſervation will not diſcover the leaſt unſteadineſs to be produced by it. Or, if the machine be filled with air, by opening the cock more or leſs, an equable blaſt may be ſupported for more than the ſpace of an hour.

In order to ſupply the enamellers' lamp with air by means of the hydroſtatic blow-pipe, it is only neceſſary to ſubſtitute this inſtrument for the bellows commonly uſed for this purpoſe. There will then be nothing novel in the manner of operating, excepting, 1ſt, That the relative ſituation of the flame and the pipe is to be regulated by turning the ſcrew S, or by ſliding backward or forward the block through which it paſſes; and, 2dly, That in lieu of the frequent movement of the foot, neceſſary with the common bellows, in the ſpace of one minute, and with fifteen ſtrokes of the handle, as much air may be drawn into the hydroſtatic blow-pipe as will blow for one hour; and as the caſk and pipes are completely air-tight, the blaſt may be ſtopped, or its ſtrength increaſed or diminiſhed at pleaſure, by turning more or leſs the cock of the pipe delivering the air.

The flame of the enamellers' lamp is not uſed excluſively for the purpoſes of the artiſt from whom it takes its name. It is this modification of the principle of the blow-pipe which is applied to the moulding of glaſs inſtruments. But in heating glaſs with this flame, an inconvenience ariſes from the impoſſibility of expoſing both ſides of any ſubject to the ſame heat, unleſs it be conſtantly turned round; for, if only one ſide of a large glaſs tube be applied to the flame, the part expoſed to its action will be fuſed before the other will be ſoftened, and if it be turned round conſtantly a much longer time will be required to melt it. Indeed ſome large tubes of

refractory

refractory glafs, which are not to be melted while undergoing this rotatory motion, may be readily fufed in any fpot conftantly expofed to the action of the flame.

In order to produce a flame which fhould be free from the inconveniences juft defcribed, I procured the oblong lamp with two wicks W, X, Fig. 1. It may be obferved, that thefe wicks are fixed on two plates, which flide in a groove, in the direction of the length of the lamp. They may therefore be made to approach to, or recede from each other. This lamp being as reprefented in the engraving placed on the little ftand T V, fo as that one of the wicks was before the orifice of the ftraight mouth-piece, above X; the bent blow-pipe at W was fo adjufted to the other wick, that when they were both lighted, and a blaft paffed over them, their flames met each other as reprefented in the plate. The refult of this was, that a much larger tube could be fufed by the united action of two flames, than could be melted with one of them; and the parts being more equally heated, a bend could be made more regularly, and with lefs danger of collapfing.

It may be proper to obferve that the machine reprefented in the plate is much more complex and expenfive, than is requifite for the purpofes of the mouth blow-pipe, or enamellers' lamp, fimply. But it is expected that artifts, availing themfelves of the principles of the machine, will reject thofe appurtenances which are unneceffary to their peculiar purpofes *.

[To be continued.]

XXXVII. *Memoir on the Fabrication of Charcoal in the Foreft de Benon, near Rochelle. Addreffed to the French Council of Mines, Nivofe* 30, *Year* 10. *By* C. Fleuriau-Bellevue †.

FUEL of every kind is fo fcarce in the neighbourhood of Rochelle, that there are few manufactories in that quarter, and none of thofe which confume a large quantity of that article can be eftablifhed. Wood is fold exceedingly dear, and there is fcarcely a quantity fufficient for diftilling the wines of the country.

* The coft of the machine reprefented in the plate was about twenty dollars; but a machine fully equal to the purpofes of the mouth blow-pipe, or enamellers' lamp, may be made for one fifth of that fum.

† From the *Journal des Mines*, No. 65.

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It is no doubt to this high price of wood, and the neceffity of deriving as much advantage as poffible from the few forefts in the neighbourhood, that we are indebted for a method of fabricating charcoal which feems to be practifed no where elfe. At any rate, from the filence refpecting it in the *Collection des Arts et des Métiers,* and in *La Nouvelle Encyclopédie,* and from the furprife expreffed by feveral perfons on feeing, in the market of Rochelle, pieces of charcoal of fuch a fize and length that they could be tied up and tranfported in the form of faggots, there is reafon to prefume that it is not known.

The Council of Mines, defirous to collect every thing that can contribute to the fuccefs of the different eftablifhments of the republic, requefted me to make known the procefs. What I have been able to collect on the fubject is as follows:—

The charcoal of the foreft of Benon is fold at Rochelle 25 or 30 per cent. above the price of every other charcoal fabricated from the fame kind of oak brought from the neighbouring departments. The wood of this foreft may have fome fuperiority over that of others: it grows flowly, is hard and heavy; but, as it appears that the fame means of fabrication are not employed in other places, a fmall part only of the great difference in the prices of charcoal can be afcribed to this fuperiority of the wood.

The care taken to place the furnace in the centre of furrounding walls, which, by checking the current of the inferior air, renders the operation of charring more uniform and more perfect, with fome other circumftances which will be mentioned hereafter, feem to contribute in a fpecial manner to the advantage in queftion.

The heaps of wood which are to be converted into charcoal, are everywhere almoft difperfed throughout the forefts, and remain expofed to the action of the air in every direction; but at Benon the charcoal is fabricated in chambers.

Thefe chambers are 20 feet fquare: the walls, built of rough ftones, united by means of earth, are 15 feet in height, and are covered with planks and tiles, arranged in fuch a manner, that between the planks a fpace of two inches is left, to afford a free paffage to the fmoke.

The floor of the chamber is convex: a mafs of argillaceous earth rifes in the centre about fix or feven inches, having between it and the wall a circular fpace two feet and a half in breadth, and the four corners free for the fervice of the furnace.

The only wood employed is oak, known under the name

of black oak, and very rarely white oak *. That cut within the current year is uſed, and never that of the preceding.

The wood is ten, twelve, or fifteen years old, and the lower part of the tree is never ſeparated. It however, in general, does not exceed ſix inches in diameter. It is cut into pieces from three feet eight inches to four feet in length, called *billets*.

They are placed upright, without being ſplit, reſting, with the ſide cut into a ſlope like the mouth of a flute, on the maſs of earth, and in ſuch a manner that they all touch each other; thoſe at the circumference only being a little inclined; and, contrary to the general practice of thoſe who char wood, one ſtory only is formed. Care is taken to mix theſe billets with ſmall branches; but twigs are never introduced, except in the centre of the furnace, merely to kindle it. Two cords of wood are ſometimes employed at one time†.

When the furnace is conſtructed, and is very round, ſtakes, a foot in height, are planted round it, at the diſtance of half a foot: it is then covered with dry graſs, ferns ‡, or *paleines* §, to the thickneſs of four inches in every direction; and over theſe is placed coal earth *(terre de charbonicre)* to the ſame height on the ſides, and to the height of 15 inches on the ſummit. In this ſtate, there remains around this focus, called the *furnace*, the circular ſpace before mentioned of about a foot and a half in breadth.

The earth employed is an argil mixed with calcareous earth: it is never removed from this incloſure, where it is baked to ſuch a degree that it might be taken for aſhes, with which it is mixed. It is then called *terre de charbonicre*. In other countries, it is known by the name of *fraſin* or *fraſil*.

Fire is applied in the centre by means of a light placed at the end of a ſtick, introduced by a paſſage formed at the lower part of the furnace. The crevices are ſtopped as ſoon as they appear, and the uſual practice is followed in this reſpect, that the fire may be perfectly regular.

When the wood is charred, half a barrel of water is thrown over it, and then it is covered to the height of five or ſix

* Theſe are varieties of the *quercus robur*. In this ſpecies are diſtinguiſhed the *white*, *red*, and *black*.

† A cord is eight feet in length, four feet in height, and nearly four in breadth.

‡ *Pteris aquilina.*

§ A kind of graſs of the genus *bromus* or *triticum*.

 inches

inches with earth: it is then ſuffered to cool for a day, and the charcoal is taken out. This operation laſts eight days in winter, and only four in ſummer. At the latter period the furnace is watched day and night.

The pieces of charcoal extracted are often three inches and more in diameter, and ſufficiently long to be made up into bundles, which are tranſported on the backs of mules to the diſtance of five or ſix leagues: the ſmaller fragments are put into ſacks.

This charcoal, which is very black, exceedingly brilliant, and ſonorous, has two qualities which cauſe it to be much ſought for in preference to all others; it poſſeſſes more activity, and laſts longer. It is attended with the inconvenience of emitting an odour, but it is well known that this is one of the characters of the beſt charcoal.

It is preferred for the kitchen, and for ironing linen. For the latter uſe it is put into iron boxes, called at Rochelle *flaſques*. It is employed alſo by blackſmiths when they have no common coals. That in large pieces is moſt eſteemed.

The latter is ſold at ſeven or eight francs per cwt. delivered at Rochelle; but if the foreſt of Benon were taken proper care of, this price might be diminiſhed *.

This method of making charcoal differs from that deſcribed in the *Collection des Arts et des Metiers*, thoſe of Brie and Burgundy mentioned in the *Encyclopedie*, and thoſe in the departments around Paris.

1ſt. By the incloſure of walls, which muſt ſecure the furnace much better than the hurdles employed in thoſe countries, and which the workman places when he thinks proper on the ſide from which the wind proceeds, this incloſure muſt render the charring more uniform and more economical.

2d. By the care taken not to reſerve for firewood, as is done in ſeveral places, the lower part of the wood, which, being more compact than the branches, ought neceſſarily to furniſh better charcoal.

3d. Becauſe the pieces of wood are longer, and twice as large as thoſe employed in the other methods, and becauſe they are put into the furnace without being ſplit.

4th. Becauſe, inſtead of raiſing, as uſual, four or five ſtories, diſpoſed in the form of a cone or pyramid, one only is

* There are reckoned to be eighteen furnace chambers in the village of Benon, and one at Lalaigne. The foreſt was ſo much deſtroyed during the revolution, that at preſent no more than ſeven or eight chambers are occupied It ſcarcely ſupplies enough of firewood. No more than 20,000 weight of charcoal is fabricated on it. About thirty or forty years ago it furniſhed ten times as much.

conſtructed,

conſtructed, which renders the action of the current of air much more moderate, and prevents the conſumption of the wood, and perhaps of a part of the hydrogen, which it is eſſentially neceſſary to preſerve in the charcoal.

5th. By the practice followed at Benon of throwing a certain quantity of water over the furnace when the wood is charred. This practice is not mentioned in the works already alluded to.

The foreſts of Chizai and Aunai, which, except that of Benon, are neareſt to Rochelle, furniſh charcoal, which is fabricated alſo from pieces of wood of the ſame ſize, which are put into the furnace in like manner without being ſplit; but the difference in the choice of the wood, and particularly in the fabrication, which takes place in the open air, makes a difference of 25 or 30 per cent. in the price of the charcoal. This difference is ſometimes greater when compared with that of other foreſts.

In the proceſs therefore here deſcribed, there is a ſaving of wood, and at the ſame time the product acquires a greater value.

XXXVIII. *On the Northern Magnetic Pole of the Earth. By* Jerome Lalande *.

It has been known for more than two centuries, that the magnetic needle does not point exactly north, and that its declination from that direction is different in different places. Reſearches therefore have been made to determine the point of the earth towards which the magnetic needle turns; and this object engaged the attention of Dr. Halley in 1683, of Euler in 1745, of Lemonnier in 1776, and of Buffon in 1788. About five years ago Mr. Churchman, a native of America, came to Paris to induce government to ſet on foot a voyage to the north pole, for the purpoſe of determining the poſition of the magnetic pole in the north. In the year 1794 he publiſhed a work, in which he propoſes a theory by which the declination of the magnetic needle can be determined for different periods and different places. I endeavoured to compare it with the lateſt obſervations. Thoſe of which I have already ſpoken in the *Connoiſſance des Tems* † were made at Nootka Sound in 48° 36′ north lat. and 129° long. weſt from Paris, in the year 1778; and the declina-

* From *the Connoiſſance des Tems pour l'an.* xii.

† An. iv. p. 215.

tion

tion there was 19° 44′ weſt. In the ſuppoſition that the lines of direction lie in the planes of great circles, and meet in one point, I found it to be in 77° 4′ north lat. Euler in the Memoirs of the Academy of Berlin places it in 75°; Lemonnier, in the *Lois du Magnetiſme*, in 73°; and Buffon, in 71°; which makes the differences to be very ſmall. Euler conceived two magnetic poles, which are not diametrically oppoſite to each other. The two obſervations which form the ground of my calculation were made, however, near enough to the north pole to enable us to determine it independently of the ſouth pole. Churchman places the north pole in the lat. of 60°; a difference which would be too great.

The two obſervations here alluded to would give the longitude of the magnetic pole in too doubtful a manner, as the angle at the pole is too obtuſe. I endeavoured, therefore, to obtain an intermediate obſervation, and found that, in the year 1770, at Norreton, in lat. 40° 10′ north, and long. 77° 36′ weſt from Paris, the declination was 3° 8′ *. From this it would follow, that the longitude of the magnetic pole is 110° 35′ weſt from Paris. The year, however, of the laſt obſervation does not correſpond with that of the two former ones: but the difference on this account cannot be of much importance.

At the time of the tranſit of Venus over the ſun's diſk in 1779, obſerved at Hudſon's Bay, in lat. 58° 48′ north, and long. 96° 30′ weſt from Paris, the declination of the magnetic needle was found to be, in that place, 9° 41′ weſt †. This gave me for the longitude of the magnetic pole only 86° weſt from Paris. The mean of the two obſervations, therefore, would be 98°. Euler makes the longitude 115°, and Buffon 100° weſt from Paris: Lemonnier makes it only 50°. But, as the parallel at ſo high a northern latitude is only of ſmall extent, a more conſiderable difference in longitude would have no great influence on the previous determination of the true poſition of the magnetic pole.

We can therefore admit the given data till a ſeries of more accurate obſervations of the declination of the magnetic needle, and its variations, collected for different determinate places, ſhall enable us to deduce from them the variations of the magnetic pole. The variations of the magnetic declination have been obſerved at Paris for 140 years; but as this has not been the caſe in America, we ſtill want the proper data for calculating the motion of the magnetic

* American Tranſactions, p. 117.

† Phil. Tranſactions 1769, p. 483.

pole:

pole: it seems only to appear that Churchman's hypothesis corresponds very little with the observations which I have calculated, and that the northern magnetic pole lies on the north-west coast of Baffin's Bay, nearly where the entrance of Alderman Jones is to be sought for on Buache's chart of 1782, and where Ferrer Maldonado touched in 1598, according to a Spanish memoir read some years ago in the Academy of Sciences; which, however, seems to deserve very little credit.

XXXIX. *Of the State of Vapour subsisting in the Atmosphere.* *By* Richard Kirwan, *Esq. F.R.S. and P.R.I.A.*

[Concluded from p. 143.]

THE dilatation of the moisture contained in the air has been separately examined by Mr. Schmidt, and he has shown how from it the volume of air saturated with moisture, saturated, I say, at every degree of Reaumur, may be discovered: the results of his experiments appear in the following table of the volume which 000 measures at 32° of air would acquire if *saturated with moisture* at each degree of Reaumur above 32°, expressed on Fahrenheit's scale *.

Reaum.	Fahren.	Expansive Force.	Reaum.	Fahren.	Expansive Force.
1°	34·25°	1010·56		70·25°	1122·68
	36·5	1010·78		72·5	1132·25
	38·75	1016·45		74·75	1142·53
	41·	1022·21	20	77·	1152·83
5	43·25	1028·58		79·25	1164·02
	45·5	1034·97		81·5	1175·23
	47·75	1040·41		83·75	1186·52
8	50·	1048·52	24	86·	1198·59
	52·25	1056·26	25	88·25	1211·44
10	54·5	1064·72		90·5	1223·65
	56·75	1071·28		92·75	1279·62
12	59·	1078·52	28	95·	1377·09
	61·25	1087·11		97·25	1494·02
	63·5	1095·76	30	99·5	1610·02
15	65·75	1104·46		101·75	1725·49
16	68·	1113·21	32	104·	1849·96
			33	106·25	1983·42

* To prevent mistakes, it must be noted that this table is not meant to express the dilatations of air saturated at any particular degree of heat it would acquire at other superior degrees, but only the bulk that 1000 parts dry air at 32° would acquire by saturation at each higher degree.

Note.

Note.—1mo. Hence we fee that air faturated with moifture at high heats is much more expanded than dry air of the fame temperature, as De Luc and general Roy have alfo obferved; but in temperatures below 36·5° dry air is more dilatable; which probably induced Sauffure to conclude it was fo at higher temperatures. At 54·5 the difference is very perceptible; for 1000 parts *dry* air at 32° are expanded at 54·5°, that is, by 22·5° above the freezing point to 1044·67; whereas 1000 parts of air faturated with moifture are extended to 1064·72, and in higher heats, the differences of expanfion are incomparably greater.

2do. Hence it is plain why moift air, fuch as that of the Weft Indies, is much more fuffocating than dry air of the fame temperature: for 1000 cubic inches of air, faturated with moifture at 86° of Fahrenheit, contain nearly 76 inches of moifture which is ufelefs to refpiration.

3tio. Thefe experiments agree with thofe of general Roy in which fteam was introduced at hazard; for the general found that from 32° to 52° each degree gave at a mean 2·588, and confequently thefe 20° would expand 1000 inches to 1051·76; and by Schmidt's experiments, much more accurately made, we have 1050·33.

4to. Schmidt alfo obferved a peculiarity in the expanfion of moift air, previoufly noticed by Roy; for Schmidt found that the expanfibility of air, faturated with moifture, was fmaller than the expanfibility of pure vapour until the 167th degree of Fahrenheit; but in higher degrees they conftantly approached nearer to each other. And the general obferved that the mean rate of expanfion, which from 152° to 172° of Fahr. was 12 for each degree, did, from the 172° to the 192°, increafe to 17·88 for each degree, and increafed ftill more after the 192d to the boiling point. The fluggifhnefs of expanfion of air, faturated with moifture at about 32°, was alfo noticed by the general; and he hence concludes the mean rate of expanfion from 0 to 32° of Fahr. to be 2·27 for each degree, which is fmaller than that of drier air.

Thefe variations of the rates of expanfibility of moift air, faturated at different temperatures, Schmidt very juftly attributes to the variation of the degrees of affinity or adherence of air and vapour to each other at different temperatures. At 32° Fahr. it is very ftrong, and alfo below that degree; and hence the ftrong folvent power of air colder than the water it acts upon, remarked by Richman: but if both are equally cold, very little moifture will be taken up by the air, as already mentioned: and hence I have faid that air diffolves vapour

vapour when this is in a naſcent ſtate. But in heats above 167° or 170° air and vapour are diſpoſed to ſeparate.

5to. Hence we may deduce the impoſſibility of diſcovering a co-efficient univerſally applicable to expreſs the rate of expanſion of air in every ſtate of moiſture, as Tremley has well noticed. (See *Sauſſure Voy. aux Alpes*, ii. 4to.) This muſt vary with the mean ſtate of hygrometers above and below the heights to be meaſured: and experiments of this kind have not yet been made. De Luc's co-efficient anſwers tolerably well for very dry air, that is, whoſe ſaturability is greateſt; ſir George Schuckburgh's, for air much moiſter; and general Roy's, for air ſtill moiſt, that is, whoſe ſaturability is ſmalleſt. Hence each ſucceeds in certain caſes, and fails in others. The dilatation or contraction which air ſaturated with moiſture at any one given degree of temperature receives without the addition of any more moiſture, at any higher or lower degree of temperature, has not as yet been diſcovered: for Schmidt, who alone has attempted it, is juſtly diffident of the correctneſs of the table he has given of it; and, in fact, it is not grounded on the indication of any known hygrometer, and improperly ſuppoſes the 50th degree to indicate the mean betwixt the loweſt and ſaturation: whereas the 65th degree on Sauſſure's indicates that mean; and 98, and not 100, indicates ſaturation.

According to Mr. Watt (as ſtated by De Luc, Meteorology, iii. p. 145), the ſpecific gravity of pure vapour is to that of air as 4 to 9. I ſuppoſe he compares it with air at the uſual denſity of 30 or 29, and at ſome particular temperature which is not mentioned; for at high temperatures the difference muſt be much greater, as appears by the foregoing tables.

M. Sauſſure (Hygrometer, p. 284,) has given us the ſpecific gravity, not indeed of pure vapour, but of vapour diſſolved in air, with more preciſion; for he tells us, 1mo. That a cubic foot of perfectly dry air has its volume augmented by $\frac{1}{54}$th, when ſaturated with ten grains of moiſture at about 65° Fahr. of heat, and barometer 28·77 inches (Engliſh).

2do. That a cubic foot of *pure* or perfectly dry air of that denſity and at that temperature weighs 751 grains (French); and after diſſolving 10 grains of moiſture, by which it is dilated $\frac{1}{54}$th, this new volume weighs $751 + 10 = 761$ grains: but a cubic foot of *pure* air, augmented by an acceſſion of 1-4th of its bulk of pure air, would weigh $751 + \frac{1}{54} 751 =$ 765 grains, that is 14 grains more. Hence he infers that, in this caſe, the ſpecific gravity of the diſſolved moiſture is to that of dry air as 10 to 14; for $\frac{1}{54}$th of a cubic foot in the one caſe weighs 10 grains, and in the other 14 grains nearly.

But I ſtrongly ſuſpect that the original experiment, on which this calculation is founded, is erroneous, chiefly by reaſon of the ſtrong adherence of moiſture to cold glaſs, as will hereafter be ſeen in treating of dew. From Schmidt's experiments it may be inferred that the ſpecific gravity of vapour, diſſolved in air at this temperature, is much lower with reſpect to that of pure air than Sauſſure has ſtated; for he tells us that about 1066 meaſures of dry air in temperature 65°, would, if ſaturated with moiſture at that temperature, occupy the ſpace of about 1100 meaſures, and conſequently receive an augmentation amounting to about $\frac{1}{32}$d of their bulk: now, transferring this ratio to the cubic foot in Sauſſure's experiment, it appears that $\frac{1}{32}$d of a cubic foot thus added to the cubic foot of dry air weighs 10 grains; but a cubic foot of dry air, augmented by an acceſſion of $\frac{1}{32}$d of ſimilar air, would weigh 751 + 23·46 grains, which approaches nearly to Mr. Watt's ratio: therefore the ſpecific gravity of vapour diſſolved in air at this temperature is to that of perfectly dry air as 10 to 23·5 nearly. It ſhould however be recollected that M. Sauſſure found that a cubic foot of dry air in reality took up 11·069 grains of moiſture when ſaturated at this temperature, and that it was only by way of conceſſion to thoſe againſt whom he argued, that he ſtated the weight taken up at 10 grains; then we ſhould have of 11·069 to 21·195, or, in round numbers, as 11 to 21, or 10 to 19. And it ſhould further be remarked that the temperature is given very looſely, for it is ſtated to be from 14 to 15° or 16° of Reaumur. See Hygrometer, p. 104 and 284.

Sauſſure has given us a table, by the help of which the abſolute quantity of vapour at any barometrical height, in a cubic foot of air, being known, the proportion and abſolute quantity in a cubic foot, at another barometrical height 3·6 inches lower, may be known from the mercurial height 28·77 to that of three inches and one-half nearly.

This table I here give, adapting it to our meaſures.

Barometer	Ratio.
28·77	1·0000
25·17	0·9528
21·57	0·8899
17·97	0·8264
14·37	0·7629
10·77	0·6887
7·17	0·6230
3·57	0·4311

Thus, ſuppoſing the abſolute quantity of diſſolved vapour at any temperature, and barometer 28·77 to be 10 grains per cubic foot; then the quantity of vapour at a height at which a barometer would ſtand at 25·17 inches would be 10 × 0·9528 = 9·528, and at the height at which a barometer would ſtand at ſeven inches, the quantity in a cubic foot would be only 10 × ·6230 = 6·23. But ſtill it is ſuppoſed that at thoſe great heights,

heights, at which barometers would stand so low, that the air is of the same temperature as the original experiment is made at, namely in this case, as it is found at barometer 28·77 inches; but since in reality air at great heights is generally much colder than below, to ascertain the real proportion of vapour at those heights it will be necessary to find the quantity of vapour which a cubic foot of air is capable of holding at that temperature barometer 28·77, and the ratio which the quantity or weight of vapour actually found, bears to the complement at that temperature. Then, 2do. to find the complement of a cubic foot of air at the temperature which prevails at the given barometrical height, and diminish it in the same ratio in which it was found diminished below; and finally, diminish it still further in the ratio which that barometrical height demands. An example will fully explain this rule.

Thus Saussure found, barometer 28·77 and thermometer 82° of Fahr., a cubic foot of air contained about 10 grains of moisture at Geneva. Now the complement of 82° is nearly 15 grains, and the ratio of 10 to 15 is $\frac{2}{3}$. Then at Mount Blanc, on the same hour, the barometer stood at 16° and the thermometer at 26·8°: the complement of a cubic foot of air at this temperature is 5·3 grains, which diminished in the ratio of 2 to 3 becomes 3·5; and this, further diminished by the ratio which the barometrical height of 16 inches demands, namely ·78 = 3·5 × ·78 = 2·7 grains, by observation it was found to be 1·7: the difference is only one grain. *Voy. aux Alpes*, § 2007. How the temperature which prevails at those great heights may be found, will be shown in the sequel.

The celebrated Lambert of Berlin (Mem. Berlin 1772,) has also given an estimate of the proportion of vapour which prevails in the atmosphere at different barometrical heights, deduced from calculations founded on many fictions—such as that of a homogeneous atmosphere, of pure air distinct from common air, and an erroneous system of the ascent of heat; yet, as it is much easier in its application, and in the instance just quoted approaches very near the truth, I have calculated the results of his system, which is nothing more than that the quantity of vapour at different barometrical heights above the earth is in the ratios of the squares of those heights. By a homogeneous atmosphere it is probable he meant such a state of the atmosphere as prevails in serene unclouded weather; and it is certainly only in such an atmosphere that any calculation can be instituted.

Table of the Ratios of the Quantities of Vapour at different barometrical Heights, the Quantity at the Surface of the Earth being given.

Barometer.	Ratio of Vapour.	Barometer.	Ratio of Vapour	Barometer.	Ratio of Vapour.
30·	900	24·	576	12	144
29·5	870	23·	529	11	121
29.	841	22	484	10	100
28·5	812	21	441	9	81
28·	784	20	400	8	64
27·5	756	19	361	7	49
27·	729	18	324	6	36
26·5	702	17	289	5	25
26·	676	16	256	4	16
25·5	650	15	225	3	9
25·	625	14	196	2	4
24·5	600	13	169	1	1

Thus, in the example laſt quoted, the quantity of vapour in a cubic foot at Geneva being 10 grains, barometer 28·77, the quantity on Mount Blanc, barometer 16, ſhould be ·309; for as 827·7 ($=\overline{28{\cdot}77}$) is to 256 ($=\overline{16}$), ſo is 10 to 0·309, which differs from the truth by only 0·391 of a grain.

As vapours unite to air, partly through the agency of heat, and partly through that of affinity and of electricity, ſo they ſeparate from it, ſometimes from a diminution of that degree of heat which they poſſeſſed in their naſcent ſtate, ſometimes from a diminution of affinity, and ſometimes from an alteration in their electrical ſtate.

In their firſt degree of coaleſcence when ſeparated from air, they form aggregates of exceeding minute particles, ſeparated from air by the diminution of affinity, and alſo from each other by electrical atmoſpheres: theſe aggregates are of equal and often lower ſpecific gravity than the air in which they are formed, and yet are viſible by reaſon of their opacity; when near the earth, they are called *fogs, miſts,* or *haze,* (which differ only in denſity,) and when at greater heights, *clouds.*

Vapours iſſuing from water or moiſture warmer than the air to which they unite, are ſoon cooled by it, and thence in great meaſure diſmiſſed: hence the morning miſts obſerved in ſummer and the winter miſts of the colder regions: evening miſts, on the contrary, proceed from the ſuperſaturation of air with vapours previouſly diſſolved, ariſing from the ſu-

pervening

pervening decreased temperature. The inferior strata of the atmosphere are scarce ever supersaturated by vapours arising from water or moisture warmer than the air into which they ascend; for, before the point of saturation can be attained, their affinity to the portion of air to which they are united is weakened, and thence exceeded by the unincumbered affinity of the superior strata: and this happens successively on to the higher regions; but with diminished activity, by reason of the diminished density of the higher strata, until their ulterior progress is checked by saturation; but as they are still continually recruited from below, their quantity is at last so far increased that they coalesce into clouds. Here the process recommences; for from the surface of these clouds a fresh evaporation often takes place, which, after some progress, is again checked in its turn, and clouds are formed at a superior height: these again give room to a further evaporation, and a new stage of clouds is formed, until the process is at last arrested by the intense cold of the superior regions. But the mere cold of congelation is not sufficient to arrest it; for Bouguer informs us that clouds are formed 2500 feet above the lower line of congelation, and that ice itself evaporates, though cooled, several degrees below the freezing point, is well known. The distance of the particles, both of air and vapour, from each other, when so far rarefied as they must be in the superior regions of the atmosphere, prevents their coalescence in any but the extreme degrees of cold.

Hence we see that in the warmer latitudes and seasons various strata of clouds may be formed one above the other: Muschenbroeck attests that even in Holland, in August 1748, he distinctly discerned three. These distinct strata, variously electrified and otherwise circumstanced, give occasion to various phænomena, the detail of which would here be misplaced.

The clouds which commonly crown the summits even of low mountains, and often announce rain, are caused by the near approach to saturation at those elevations, and its actual attainment through the evaporation from those summits. But the summits of the loftiest mountains ever crowned with snow, are generally shrowded in clouds, from the cold they impart to the air in contact with them, and the loss of electricity conducted away from the vapours contained in that air by the mountain.

The heights at which the lowest clouds are formed, are various in various latitudes and seasons; greater in the warmer, and smaller in the colder. In latitude 54° in Cum-

berland, Mr. Crosthwaite observed none lower than 2700 feet, and none higher than 3150, in the course of several years *. But this country being mountainous, they are probably lower than in others under the same parallel. Lambert, in Berlin, latitude 52° 32′, in the month of July 1773, found their height 7792 feet; thermometer 65°, and the barometer somewhat below its mean height †. Schuckburgh also remarks that clouds frequently rest below the summit of Saleve, whose height is 2831 feet. Phil. Transf. 1777, p. 538; and Gentil, at Pondicherry, latitude 12°, observed some at the height of 10240 feet. ii. Voy. p. 79.

The weight of clouds Saussure estimates at one-third or one-fourth of that of the cubic foot of air in which they subsist. Hygrometer, p. 270. When the barometer rises, clouds are partly dissolved, as dense air is a better solvent than rarer air, and partly rise higher in consequence of the increased specific gravity of the inferior air; when the barometer falls, the contrary takes place.

XL. *Report, read before the Conference of Mines, on the Specific Gravity of the Coals of several Mines of France; and on the Difference in the increase of Volume which they acquire by Humectation.* By C. Blavier, *Engineer* ‡.

THE conference of mines had long been sensible of the necessity of determining, with rigorous precision, the specific gravity of coals in masses or in large fragments, in order that it might be compared with that of the same article as sold by the coal merchants. This object was at the same time of more importance, as it would make known what difference humectation would produce on the volume which coals occupy in their state of dryness.

C. Duhamel and Blavier proposed to accomplish this object in the execution of a labour with which they were charged, in order to confirm the different assertions already established by one of them, in a memoir delivered to the conference on the 12th Pluviose, year 7.

These commissioners wished to take as a fixedand invariable base, the *solid* coal, or such as it is when extracted from the mine, that they might afterwards proceed progressively to that reduced to different degrees of attenuation, and particu-larly

* D'Alton's Meteorological Observations, p. 41.

† Mem. Berlin 1773, p. 44.

‡ From the *Journal des Mines*, No. 65.—We have inserted this paper as it may furnish useful hints for similar experiments on the varieties of coal in Britain, which are so numerous.

larly to those which it experiences till the moment when it passes into the hands of the consumer: but they were obliged to confine their experiments to each of those kinds of coal placed at their disposal by the council, and which were transmitted to them directly by the workers of the mines of Creusot, St. Etienne, Lataupe, Labarthe, Lacomballe, and Decise.

The method by which they were able to ascertain the specific gravity was as follows:

After bringing the different kinds of coal above mentioned to the uniform size of pease or beans, by sifting them, and having carefully picked out all the earthy or schistous particles, the commissioners filled a decalitre with each of them, taking care to choose those in the highest state of dryness, and to pour them in without any shock, as merchants do who measure them on the ground or in their barges. The weight of each decalitre being ascertained, the dry coal contained in the vessel was then watered in succession without shaking or displacing it; and this was continued till the water floated over the surface. The coals thus moistened were again weighed, and the difference of weight indicated the specific gravity required, since this article is impermeable to water, which only fills up the vacuities left between the grains of the bruised coal by their uniting under a greater or less obtuse angle.

In regard to the increase of weight arising from humectation, it will be sufficient to decant the supernatant liquor; and the difference of the two, weighed as above, expressed this second result.

They then moistened successively, and in different proportions, each kind of coal; suffered the superfluous water to drain off for a quarter of an hour; and, comparing the volume of the dry matter with that which it occupied at different degrees of humectation, were able to discover the progressive increase or diminution by employing for this purpose a wire placed exactly level with the surface of the vessel.

The table annexed exhibits the series of the comparative experiments: indicating for each hectolitre of the kinds of coal before mentioned the weight of that article in its state of dryness; that of the water introduced, which may be considered as solid; the increase of weight in the moistened coals; the augmentation of its volume arising from greater or less humectation; the number of parts of solid coal in a hundred parts of dry coal, and the specific gravity of the latter.

It follows, from the labour of C. Duhamel and Blavier, 1st, That the increase of weight is always in the direct ratio of the quantity of water added, which itself increases accord-

ing to the degree of the trituration of the coal, and in the inverſe ratio of the ſpecific gravity of the article. 2d, That the latter alſo is in the inverſe ratio of the weight of the liquid which the dry coal retains after decantation. 3d, That the increaſe of volume is the more ſenſible as a greater quantity of humectation has been produced; and that there exiſts a term at which the addition of water occaſions no change, and beyond which the volume decreaſes in determinate proportions. 4th, In the laſt place, that all theſe reſults vary not only in regard to the different kinds of coal, but even in the ſame kind of coal, according to its nature, its mixture with parts more or leſs earthy, and particularly its ſize or degree of trituration.

The moſt natural concluſion to be deduced from theſe experiments is, that in the ſale of coals there may be introduced abuſes, which it will be of more importance to reform, as in 100 parts of dry coal there are ſcarcely 70 parts of ſolid coal; and beſides, it is proved, that from humectation carried to a certain degree, there may reſult an augmentation or diminution of volume to the loſs of the conſumer or even of the merchant himſelf.

In conſequence of theſe conſiderations, C. Duhamel and C. Blavier, in a report dated Pluvioſe 8, year 10, have concluded that the ſale of coals by weight is attended with the ſame inconveniences as thoſe which take place in a determinate meaſure of capacity. They perſiſt in believing that the combinations of the two methods could not be employed but on the ſuppoſition of coal entirely dry, and yet by expreſſing a wiſh that an accurate table of the ſpecific gravities of all the coals in France, comparing them with each other in different degrees of ſize and humectation, might be drawn out. The reſult would at leaſt be approximative data, by help of which it would be poſſible to expoſe the ſhameful traffic of ſome coal-merchants, who alter the nature of their commodity by mixtures more or leſs earthy. This labour would be particularly important were it accompanied with experiments proper for determining the real value of coal in regard to the uſe for which it is beſt fitted. It is thus, for example, that C. Blavier has already found, by repeated trials, that the *pera* of Deciſe muſt be ſelected to heat reverberating and evaporating furnaces in preference to the ſmall coal of St. Etienne; while the latter, which is ſold in general for at leaſt a fourth more, may be employed with advantage in forges and in all circumſtances where a ſtrong concentrated heat is required. The mixture of theſe two kinds of coal, in the proportion of four to three, gave him an article of fuel the more valuable, as, by furniſhing a more ardent

and

and longer maintained flame, there ariſes to the conſumer a ſaving of more than a fifth, compared with the uſe of either of theſe taken ſeparately. It was with this view that the reporter propoſes to ſubject the different kinds of coals in the republic to experiences, capable of fixing, in an invariable manner, not only their peculiar uſe in commerce and in the arts, but alſo the advantages which would reſult from mixing them in certain proportions.

Table of Experiments on the Specific Gravity of different Kinds of Coal, and on the Increaſe of Weight and Volume which they acquire by Humectation.

Names of the Coals.	Weight of the dry coals per hectolitre. Kilogr.	Weight of the water introduced per hectolitre of dry coal. Kilogr.	Increaſe of weight in the moiſtened coals per hectolitre. Kilogr.	Increaſe of volume of the moiſtened coals per hectolitre. Decalitres	Number of parts of ſolid coal in 100 parts of dry coal.	Weight of the dry Coal. Per hectolitre. Kilogr.	Per cubic foot. Pounds.
Mine of Labarthe.	88·50	36·10	9·50	1·67	63·9	145·32	97
Mine of Combelle.	86·07	41·53	17·50	2·50	58·5	136·42	95
Mine of Lataupe.	85·50	42·00	19·50	2·50	58·0	135·09	94
Mine of St. Etienne.	84·20	47·10	26·80	1·67	52·9	128·74	90
Mine of Deciſe.	82·75	50·75	29·95	2·50	49·3	125·55	88
Mine of Creuſot.	79·50	52·75	47·90	2·50	47·25	117·75	85

XLI. *Memoir on the Wax-Tree of Louiſiana and Pennſylvania.* By Charles Louis Cadet, *of the College of Pharmacy* *.

A Number of plants, ſuch as the *Croton ſebiferum*, the *Tomex ſebifera* of Loureiro, the poplar, the alder, the pine, and ſome *labiati*, give by decoction a concrete inflammable matter, ſimilar, in a greater or leſs degree, to tallow or wax; that is to ſay, a fixed oil ſaturated with oxygen. The light down, called the bloom of fruits, and which gives a ſilvery appearance to the ſurface of plums and other ſtone fruits, is wax, as has been proved by M. Prouſt. But the tree which furniſhes this matter in the greateſt abundance, and which in many reſpects deſerves the attention of agriculturiſts, chemiſts, phyſicians, and commercial men, is the *Myrica cerifera*, or wax-tree.

We read in the Hiſtory of the Academy of Sciences for the years 1722 and 1725, that M. Alexandre, a ſurgeon and correſpondent of M. Mairan, obſerved in Louiſiana, a tree of the ſize of the cherry-tree, having the appearance of the myrtle and nearly the ſame odour, and bearing a ſeed of the ſize of coriander. Theſe ſeeds, of an aſh-gray colour, contain a ſmall oſſeous ſtone, pretty round, covered with ſhining wax, which is obtained by boiling the ſeeds in water. This wax is drier and more friable than ours. The inhabitants of the country make tapers of it. M. Alexandre adds: "This ſeed has commonly a beautiful lake colour, and on being bruiſed with the fingers they acquire the ſame tint; but this takes place only at a certain ſeaſon."

The liquor in which the ſeeds have been boiled, and from which the wax has been taken, when evaporated to the conſiſtence of an extract, was found by M. Alexandre to be an effectual remedy for checking the moſt obſtinate dyſenteries.

The advantageous properties exhibited by this tree could not but induce ſcientific men to make reſearches for the purpoſe of aſcertaining the varieties of this vegetable production, and what care was required in its culture. It was long conſidered as a mere object of curioſity.

Linnæus, in his Vegetable Syſtem, ſpeaks only of the wax-tree of Virginia (*Myrica cerifera*), with leaves lanceolated as if indented, ſtem arboreſcent.

Having requeſted C. Ventenat to inform me how many ſpecies there are of it, he replied that Ayton has diſtinguiſhed two, viz.

* From the *Annales de Chimie*, No. 131.

1ſt, *Myrica*

1st, *Myrica cerifera angustifolia*, which grows in Louisiana. This tree is delicate, flowers with difficulty in our green-houses: its seeds are smaller than those of the following.

2d, *Myrica cerifera latifolia*, which grows in Pennsylvania, Carolina, and Virginia. It does not rise to such a height as the former, and is perfectly naturalized in France. These two *Myricæ* are of the family of the *diœci.*

They are both cultivated at the *Museum des Plantes* and in the gardens of C. Cels and Lemonier.

C. Michault admits a third species of *Myrica cerifera*, which he calls the dwarf wax-tree. C. Ventenat thinks that wax may be extracted from all the *Myricæ.*

The authors who have spoken of these trees with some details are C. Marchal, translated by Leserme, Lepage-Duprat, and Toscan, librarian of the Museum of Natural History. A memoir inserted by the latter in his work intitled *L'Ami de la Nature*, makes known the manner in which vegetable wax is collected in the colonies.

"Towards the end of Autumn," says he, "when the berries are ripe, a man quits his home, with his family, to proceed to some island, or some bank near the sea, where the wax-trees grow in abundance. He carries with him vessels for boiling the berries, and an axe to build a hut to shelter him during his residence in that place, which is generally three or four weeks. While he is cutting down the trees and constructing the hut, his children collect the berries: a fruitful shrub can furnish about seven pounds. When the berries are collected, the whole family employ themselves in extracting the wax. A certain quantity of the seeds are thrown into the kettles, and water is poured over them in sufficient quantity to rise to the height of half a foot above them. The whole is then boiled, stirring the seeds from time to time and pressing them against the sides of the vessels, that the wax may more easily be detached. A little after, the wax is seen floating in the form of fat, which is collected with a spoon and strained through a piece of coarse cloth to separate the impurities mixed with it. When no more wax detaches itself, the berries are taken out by means of a skimmer, and new ones are put into the water; taking care to renew it the second or third time, and even to add more *boiling* water in proportion as it is consumed, that the operation may not be retarded. When a certain quantity of wax has been collected in this manner, it is placed on a piece of linen cloth to drain, and to separate the water with which it is still mixed. It is then dried, and melted a second time

for the purpofe of purifying it, and is moulded into the form of cakes. Four pounds of the feeds give about a pound of wax. That which detaches itfelf firft, is generally yellow, but in the laft boilings it affumes a green colour, in confequence of the tint communicated to it by the pellicle with which the nucleus of the feed is covered."

Kalm, the traveller, fpeaking of the vegetable wax, fays that in countries where the wax-tree grows, it is employed for making excellent foap, with which linen can be perfectly wafhed.

Such was the knowledge naturalifts had of the myrica, or at leaft no other obfervations, as far as I know, had been publifhed, refpecting it, when a naturalift gave me half a kilogramme of the vegetable wax of Louifiana. I was defirous to analyfe it, and compare it with the wax made by our bees, but before I undertook this labour, I wifhed to be acquainted with the nature of the fhrub, and of the feeds of the myrica. I faw this valuable production in the *Jardin des Plantes*, and wrote to C. Defhayes, a zealous botanift, who fuperintends at Rambouillet the cultivation of the *Myrica pennfylvanica*, to beg he would give me a few details on that fubject. He was fo kind as to return an anfwer, accompanied with fome of the feeds, which I took the earlieft opportunity of examining.

This feed is a kind of berry, of the fize of a pepper-corn; its furface, when it is ripe and frefh is white, interfperfed with fmall black afperities, which give it the appearance of fhagreen. When rubbed between the hands, it renders them unctuous and greafy.

If one of thefe fmall berries be ftrongly preffed, it divefts itfelf of a matter in appearance amylaceous, mixed with fmal round grains like gunpowder. The nucleus, which remainl bare, has a very thick ligneous covering, and contains a dis cotyledon kernel. By rubbing a handful of the berries on a hair fieve, I obtained a gray duft, in which I could diftinguifh, by the help of a magnifying glafs, the fmall brown grains already mentioned, in the middle of a white powder.

I put this powder into alcohol, which by the help of a gentle heat, diffolved all the white part, and left the black powder, which I collected a-part. Water poured over this alcoholic folution, difengaged a fubftance which floated on the furface of the liquid. I melted this fubftance, and obtained a yellow wax, fimilar to that brought me from Louifiana. This experiment was fufficient to prove that the wax of the myrica is the white rough matter which envelopes the feeds.

The black powder which I feparated appeared to me to contain

contain a colouring principle, and I did not despair that I should find in it the beautiful lake, mentioned by M. Alexandre. With this view, I bruised strongly the powder, and boiled it in a solution of acid sulphate of alumine. I was much astonished to obtain nothing but a liquor scarcely coloured, and the alumine precipitated by an alkali, was only slightly stained.

I took another part of this black bruised powder, and put it to infuse in alcohol. I soon obtained a tincture of the colour of wine lees: on heating this tincture, it became as red as a strong tincture of cinchona or cachou. This result induced me to believe that the colouring principle was resinous, but by adding water I saw no precipitate formed.

I poured into this tincture water charged with sulphate of alumine; a slight precipitate was produced: a solution of sulphate of iron formed it immediately into an ink.

What is the astringent colouring principle which is not soluble in alcohol, which forms no precipitate with water, and which has so little attraction for alumine? To find it a series of experiments, which the few substances I had in my possession did not permit me to make, would have been necessary. The astringent matter mentioned by M. Alexandre, must be found in the decoction of the unbruised seeds. To ascertain this fact, I boiled the seeds in a silver vessel. The decoction on which a little wax floated, was of a greenish colour, with a taste somewhat styptic: it precipitated ferruginous solutions black. Having heated it in a very clean iron vessel, it speedily became black. To know whether this property arose from the gallic acid alone, or from tannin, I mixed a little of the concentrated decoction with a solution of gelatin, but no precipitate was formed.

It is therefore to the pretty considerable quantity of gallic acid contained in the seeds of the myrica, that the virtue of its extract in checking dysentaries ought to be ascribed. In this respect, I am of opinion that the leaves and bark of the tree would furnish an extract still more astringent than the berries.

The following are the most interesting results of an examination of the wax:

When extracted either by decoction from the seeds, or by solution of the white powder in alcohol precipitated by water, this melted wax is always of a yellow colour, inclining to green. Its consistence is stronger than that of the wax made by bees; it is dry and friable enough to be reduced to powder; in a word, it is manifestly more oxygenated than wax prepared by these insects. Tapers made with the wax of the

 myrica

myrica give a white flame and a beautiful light, without ſmoke, do not run, and when new emit a balſamic odour which the inhabitants of Louiſiana conſider as very beneficial to the ſick: when diſtilled in a retort, it paſſes in a great part to the ſtate of butter. This portion is whiter than it was before, but it loſes its conſiſtence, and acquires that of tallow. Another portion is decompoſed, furniſhes a little water, ſebacic acid, and empyreumatic oil. A great deal of carbonated hydrogen gas and carbonic acid gas are diſengaged, and there remains in the retort a black carbonaceous bitumen. Common wax when diſtilled, exhibits the ſame phænomena.

I have already ſaid that alcohol diſſolves the wax of the myrica, but ether diſſolves it much better, and, by the evaporation of the liquid, it ſeparates in the form of ſtalagmites. Neither of theſe liquids deſtroy its colour. If this wax be boiled with dilute ſulphuric acid, it becomes a little whiter, but there is no ſenſible combination of the acid with it. The yellow wax of bees, treated in the ſame manner, did not change its colour.

Oxygenated muriatic acid bleaches both kinds of wax perfectly. The vegetable wax, however, loſes its colour with more difficulty.

The vegetable wax diſſolves in ammonia. The ſolution aſſumes a brown colour: a part of the wax becomes ſaponaceous. The volatile alkali has much leſs action on the wax of bees.

Theſe two kinds of wax, when ſtrongly agitated in a boiling ſolution of cauſtic potaſh, waſh and form a real ſoap, as obſerved by Kalm the traveller. The whiteneſs which wax acquires by this ſaponification is not a new phænomenon. C. Chaptal, in his proceſs for bleaching by the ſteam of alkaline lees, has proved that the colouring principle of vegetables yields to the action of alkalies. Some chemiſts aſcribe this effect to the direct combination of ſoda or potaſh with the coloured extractive part, and a combination which brings it to a ſtate almoſt ſaponaceous and renders it ſoluble.

According to my opinion, the alkali, in this operation, exerciſes over the oil or wax a double attraction, firſt direct with the conſtituent principles of the oil, then prediſpoſing and favouring the combination of the oxygen of the atmoſphere with oil or wax. I do not know whether any one before me ever entertained this idea; but it was ſuggeſted by obſerving what takes place when ſoap is decompoſed by an acid. The oil is always concrete and more oxygenated than it was before.

It

It would be of importance for the theory of chemiſtry to make ſoap, if poſſible, in a cloſe veſſel, and to examine the air afterwards, or in different gaſes containing no oxygen.

By decompoſing ſoap of the myrica, very white wax is obtained; but in a particular ſtate, which does not admit of its being employed for our purpoſes.

Litharge, or ſemi-vitreous oxide of lead, diſſolves very well in the melted wax of Louiſiana. It forms a very hard maſs, the conſiſtence of which may be diminiſhed at pleaſure by the addition of a little oil. If the wax of the myrica, as there is reaſon to think, retains a portion of the aſtringent principle given by a decoction of the berries, the phyſicians, perhaps, will find uſeful properties in topics made with this wax.

By taking a general view of what has been here ſaid, it is ſeen that the myrica may be of very great ſervice in the arts. The wax which it furniſhes is ſufficiently abundant to prove an ample indemnification for the care and expenſe of cultivation, ſince a ſhrub in full bearing gives ſix or ſeven pounds of berries, from which a fourth of wax may be extracted. This wax is of a quality ſuperior to that of bees.

The aſtringent principle of the myrica, extracted on a large ſcale, may be very uſeful either in medicine or in the arts. In certain reſpects it may be ſubſtituted for the gall-nut in dyeing, hat-making, and perhaps in the tanning ſome kinds of leather. The colouring principle ſeems to be ſufficiently fixed to deſerve ſome attention; and, if it be true that in Louiſiana beautiful lakes are made from it, why is it not rendered uſeful in painting?

In a word, when this wax becomes ſufficiently common to be ſold at a low price, great advantage might be derived from it in making ſoap.

The art of bleaching this wax requires alſo ſome reſearches, when it is to be performed on a large ſcale with œconomy. Two re-agents preſent themſelves to manufacturers—the ſulphuric acid and the oxygenated muriatic. But as wax does not ſink in theſe liquids, means muſt be found to multiply the contact, either by cutting the wax into ſlices and beſprinkling it with oxygenated muriatic acid, or ſhutting it up when cut in this manner, in caſks, into which oxygenated muriatic acid is introduced.

I ſhall propoſe a third method, which ſeems to promiſe a ſpeedier effect. Place the wax, cut into ſmall pieces, in alternate ſtrata with hyper-oxygenated muriate of lime: when arranged in this manner, leave it for ſome time dry and in contact. The ſalt and acidulous water are then to be decompoſed by the

the sulphuric acid, taking care to pour in water gradually, at different periods, till there is no longer a sensible disengagement of muriatic gas. A large quantity of water is then to be added, and the mixture must be stirred with a rod. By rest, the insoluble sulphate of lime is precipitated, and the bleached wax will float at the surface.

I shall terminate this memoir with some observations on the culture of the myrica.

C. Deshayes, to whom I am indebted for the trials I made, has observed, for several years, the wax-trees of Rambouillet. What he wrote to me on this subject is as follows:

" The *Myrica latifolia* (Ayton) is here absolutely in its native country: it is in the soil proper for it; that is to say, in sandy and blackish turf. We have sixteen wax-trees in full vigour. They are four, five, and six feet in height: one male is seven feet. The seeds are abundant almost every year: I say almost, because in some years they fail. The fruit in general is in that part of the English garden assigned to it.

" The culture requires no care. Every year a great number of shoots, which proceed from the roots of the large trees, are pulled up. These are so many new shrubs, which are then planted at the distance of a yard from each other.

" The seeds may be sown in beds in the spring, and then transplanted: but this method is tedious. The myrica will succeed wherever it finds a light soil, somewhat moist. How many provinces are there where the cultivation of this shrub would be useful, and employ land almost neglected!

" What advantages may not agriculture hope for from such an acquisition, since Prussia has so long seen the myrica flourish in its dry, sandy plains!"

C. Thiebault, of the Academy of Berlin, gave me the following interesting note on this subject:

" The late M. Sulzer, author of a general dictionary of the fine arts, had obtained from Frederic the Great a pretty extensive piece of waste land on the banks of the Spree, at the distance of half a league from Berlin, in a place called the Moabites. However barren this ground, which presented only a very thin, poor turf, above fine light sand, might be, M. Sulzer converted it into a very agreeable garden, worthy of a philosopher. Among other remarkable things he formed a plantation of foreign trees, consisting of five pretty long alleys running east and west. In these alleys there were not two trees of the same kind following each other. In the alleys most exposed to the north he planted none but the highest trees, capable of withstanding the severity of the climate. Hence,

Hence, in proceeding from the north to the fouth, the firft alley exhibited trees of about feventy feet in height, the fecond trees of from twenty-five to thirty, and fo on, in the form of an amphitheatre; fo that all thefe trees had the fun at leaft in part, and the weaker were fheltered by the ftronger.

"In the moft fouthern alley I obferved a fort of fhrub which rofe only to the height of two or three feet, and which M. Sulzer called the wax-tree. Every perfon vifited this alley in preference to the reft, on account of the delicious perfume emitted by the leaves, which they retained a very long time.

C. Thiebault then fpeaks of the method of extracting the wax. This operation is the fame as that defcribed by M. Alexandre.

"I have feen," adds he, "one taper of this wax perfume three chambers which compofed M. Sulzer's private apartments, not only during the time it was lighted, but even for the reft of the evening."

The myrica cultivated at Berlin was, no doubt, more odoriferous than that which we poffefs, the wax of which does not emit the fame perfume.

M. Sulzer intended to make tapers of this wax not bleached, covered with a coating of our fineft wax. The heirs of this academician fold the garden, but the wax-trees ftill remain. They were planted in 1770.

If it has been found poffible to naturalize the *myrica cerifera* in the north, why fhould we neglect a vegetable production fo valuable, which would certainly thrive in our fouthern departments, and which requires lefs care than bee-hives. The fuccefsful trials which have been made muft excite the zeal of our agriculturifts.

The government has already encouraged this branch of induftry by ordering plantations of the wax-tree. There are nurferies at Orleans and Rambouillet which contain more than 400 fhrubs. Refults fo fatisfactory cannot be made too public. Ufeful plants are always propagated flowly: a barren but picturefque tree, an agreeable fhrub, are foon adopted through fafhion: they ornament the parterres of our modern Luculluses and the flower-pots of our Phrynes, while our indefatigable agriculturifts exhauft themfelves in vain efforts to enrich our meadows with a new grafs, or to fill our granaries with a new nourifhing grain. The vulgar, through prejudice, long rejected maiz and potatoes, which have been of fo much fervice to our foldiers and to the poor. The oak, which fed our anceftors, is no longer found in our forefts. Let us, however, hope that our agriculturifts will

at

at length open their eyes to their real interefts; and that, laying afide their old prejudices, they will not difdain the prefents which learned focieties are defirous to give them, and which will conduce as much to their advantage as to the glory and profperity of France.

XLII. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

ON the 30th of November, being St. Andrew's day, the Royal Society held their anniverfary meeting at their apartments in Somerfet-place, when the gold medal (called Sir Godfrey Copley's) was prefented to William Hyde Wollafton, M.D. for his various papers printed in the Philofophical Tranfactions.

Afterwards the Society proceeded to the choice of the council and officers for the enfuing year, when, on examining the ballots, it appeared that the following gentlemen were elected of the council:

Of the old council—The right hon. fir Jofeph Banks, bart. K.B.; fir Charles Blagden, knt.; Henry Cavendifh, efq.; Edward Whitaker Gray, M.D.; right hon. Charles Greville; right hon. fir William Hamilton, K.B.; Rev. Nevil Mafkelyne, D.D.; George earl of Morton, K.T.; Jofeph Planta, efq.; Benjamin count Rumford; Samuel Wegg, efq.

Of the new council—Mark Beaufoy, efq.; Andrew Douglas, efq.; fir Martin Browne Folkes, bart.; Charles Hatchett, efq.; Everard Home, efq.; Thomas Barnard, lord bifhop of Limerick; William Marfden, efq.; Jofeph de Mendoza Rios, efq.; Francis earl of Moira; William Hyde Wollafton, M.D.

And the officers were—Sir Jofeph Banks, bart. prefident; William Marfden, efq. treafurer; Jofeph Planta, efq., Edward Whitaker Gray, M.D., fecretaries.

Afterwards the members of the Society dined together, as ufual, at the Crown and Anchor tavern, in the Strand.

The Tranfactions of the Society for 1802 contain the following papers:

1. The Croonian Lecture. On the Power of the Eye to adjuft itfelf to different Diftances, when deprived of the Cryftalline Lens. By Everard Home, Efq. F. R. S.—2. The Bakerian Lecture. On the Theory of Light and Colours. By Thomas Young, M. D. F. R. S. Profeffor of Natural Philofophy in the Royal Inftitution.—3. An Analyfis of a

 mineral

mineral Subſtance from North America, containing a Metal hitherto unknown. By Charles Hatchett, Eſq. F. R. S.—4. A Deſcription of the Anatomy of the Ornithorhynchus paradoxus. By Everard Home, Eſq. F. R. S.—5. On the Independence of the analytical and geometrical Methods of Inveſtigation; and on the Advantages to be derived from their Separation. By Robert Woodhouſe, A. M. Fellow of Caius College, Cambridge.—6. Obſervations and Experiments upon oxygenized and hyper-oxygenized muriatic Acid; and upon ſome Combinations of the muriatic Acid in its three States. By Richard Chenevix, Eſq. F. R. S. and M. R. I. A.—7. Experiments and Obſervations on certain ſtony and metalline Subſtances, which at different Times are ſaid to have fallen on the Earth; alſo on various Kinds of native Iron. By Edward Howard, Eſq. F. R. S.—8. Obſervations on the two lately diſcovered celeſtial Bodies. By William Herſchel, L. L. D. F. R. S.—9. Deſcription of the Corundum Stone, and its Varieties, commonly known by the Names of Oriental Ruby, Sapphire, &c.; with Obſervations on ſome other mineral Subſtances. By the Count de Bournon, F. R. S—10. Analyſis of Corundum, and of ſome of the Subſtances which accompany it; with Obſervations on the Affinities which the Earths have been ſuppoſed to have for each other, in the humid Way. By Richard Chenevix, Eſq. F. R. S. and M. R. I. A.—11. Deſcription of the Anatomy of the Ornithorhynchus Hyſtrix. By Everard Home, Eſq. F. R. S.—12. A Method of examining refractive and diſperſive Powers, by priſmatic Reflection. By William Hyde Wollaſton, M. D. F. R. S.—13. On the oblique Refraction of Iceland Cryſtal. By William Hyde Wollaſton, M. D. F. R. S.—14. An Account of ſome Caſes of the Production of Colours, not hitherto deſcribed. By Thomas Young, M. D. F. R. S. F. L. S. Profeſſor of Natural Philoſophy in the Royal Inſtitution.—15. On the Compoſition of Emery. By Smithſon Tennant, Eſq. F. R. S.—16. Quelques Remarques ſur la Chaleur, et ſur l'Action des Corps qui l'interceptent. Par P. Prevoſt, Profeſſeur de Philoſophie à Genève, &c.—17. Of the Rectification of the Conic Sections. By the Rev. John Hellins, B. D. F. R. S. and Vicar of Potter's Pury, in Northamptonſhire.—18. Catalogue of 500 new Nebulæ, nebulous Stars, planetary Nebulæ, and Cluſters of Stars; with Remarks on the Conſtruction of the Heavens. By William Herſchel, LL. D. F. R. S.

APPENDIX.—Meteorological Journal kept at the Apartments of the Royal Society, by Order of the Preſident and Council.

FRENCH

FRENCH NATIONAL INSTITUTE.

Proceedings during the laſt quarter of the year 10, continued from our laſt Number.

NATURAL PHILOSOPHY.

Of Meteors ſuppoſed to fall under the form of Stones.

A great deal has been ſaid of ſtones which have fallen from the clouds; it was long believed that this was one of the forms aſſumed by thunder in its fall; they were then conſidered as the product of the exploſion of certain luminous balls, which are ſometimes obſerved. The rarety of theſe phænomena, however, which has not allowed of their being ſeen at a ſhort diſtance by obſervers poſſeſſed of intelligence, and at the ſame time worthy of credit, and which ſeems hitherto to have reſerved them for the eyes of the vulgar, ſo much inclined to exaggeration, has prevented the learned from believing in the exiſtence of theſe ſtones.

However, moſt mineralogical collections, contain a great number of ſtones, to which this origin has been aſcribed. They exhibit exterior uniform characters: a ſpecific gravity nearly equal, and by analyſis, give the ſame component parts, among which is nickel, a ſubſtance rarely found at the ſurface of the earth; and iron in a metallic ſtate, which is never met with in volcanic productions, to which theſe ſtones in other reſpects ſeem to be very analogous.

Theſe remarks have induced Mr. Howard, and Count de Bournon, to think that, however doubtful the fall of ſtones from the atmoſpheric regions may be, it ought to be ſubjected to accurate examination. They have collected the different teſtimonies in a paper read before the Royal Society of London, and C. Pictet thought it proper to preſent it to the claſs, that the attention of philoſophers may be directed to this ſubject, in order that the phænomenon, if true, may be confirmed; or, if only an illuſion ſupported by popular error, may be confined for ever to the claſs of errors.

CHEMISTRY.

On the Pruſſiates of Barytes and Lime.

After the baſes of a theory have been eſtabliſhed on important facts well confirmed, and when by a methodical arrangement of the ſcience they have been diſtributed, as we may ſay, into regions, the communications between which are known, it remains to review them in detail, in order that all

all the parts may be carefully described, and that these parts may be assigned to the regions which they compose. Such, it appears is the idea which may be formed of the present state of the chemical knowledge of salts. Their general formation seems to be well known, the great divisions are well established, and the principal facts have been exactly observed and classed; but notwithstanding these satisfactory labours, many details are still unknown or imperfect. Hence the researches of the chemists of the institute during this quarter have been particularly directed towards this object, and it will be seen that they have not been fruitless.

The liquor charged with the colouring matter of Prussian blue, having manifested the property of taking metals from their solvents, without producing a decomposition of the salts with an alkaline or earthy base, the phænomenon of the precipitation of barytes had been considered as an indication of the metallic nature of that substance, which could not be reduced to a metallic state, because it had a greater affinity for oxygen than carbon. The most celebrated chemists had adopted this opinion, others had announced that precipitation did not take place. Mr. William Henry thus maintaining that prussiates perfectly purified did not produce any precipitation, confirmed himself the first observations of Bergman and Lavoisier, and announced that there was formed by double affinity a real prussiate of barytes. C. Guyton, having long observed that prussiate of lime was decomposed by carbonate of potash, made use of this experiment, and those of Mr. Henry, to fix the theory of these phænomena; and, instead of concluding, like the English chemist, that barytes differs in this respect from other earths, and approaches the nature of metals, he shows that the same effect takes place with lime, strontian, magnesia, potash, soda, and even ammonia, and consequently that, in all these cases, there is nothing but the necessary result of the concurrence of several divellent forces.

On Mercurial Salts.

After treating different oxides of mercury, as already mentioned in his memoir, C. Fourcroy continued to read an account of his labour during the last quarter. In this second part he employed himself on the sulphates and nitrates of mercury; a very complex kind of compounds, exceedingly variable, the characters and properties of which have been examined by many chemists, without their being able to determine the real differences between them, and particularly the cause of these differences. The author had already made

this kind of combination the subject of his researches, and in 1791 communicated to the academy of sciences a pretty long paper on these salts. He established three kinds of them, distinguished by the proportions of acid and oxide, and he showed a difference between them, founded on the different states of oxidation of the metal.

Different sulphates are made not only by exposing mercury with sulphuric acid to a greater or less heat, and for a longer or shorter time, but also by mixing this acid or a soluble sulphate with a nitric solution of mercury, more or less oxidated. If the latter is little oxidated, a white precipitate of sulphate little oxidated is obtained; if it be much oxidated a yellow precipitate highly oxidated will be obtained; sulphuric acid united to two or three parts of water does not form sulphate of mercury much oxidated, unless it be concentrated by long and strong ebullition; without this, the water added for washing does not render the mixture yellow, and will not make turbith mineral. The author gives the proportions of the component parts, acid, oxygen and mercury, of the different neutral or acid sulphates, little or very much oxidated. These results are a supplement to his labour of 1791 on this kind of mercurial salts.

Nitrates of mercury furnished him with observations still newer and more important for science than the sulphates. There are two kinds of nitrates, one much oxidated, and the other little oxidated. The former is precipitated, of a gray colour, and almost black by alkalies, and white by sulphates; with muriatic acid it forms mercurius dulcis. The nitrate much oxidated, results from long and strong ebullition, gives no precipitate by muriatic acid, it gives a yellow one with sulphates, a white one with ammonia, and an orange yellow one with fixed alkalies. Nitric solutions of mercury, are often mixtures of the two salts. That which precipitates by water is a solution of oxide much oxidated, or red, in concentrated acid. When a nitric solution of mercury, little oxidated, is precipitated by a fixed alkali, the first portion of the white precipitate, a little coloured, which is obtained, is a nitrate of mercury insoluble and neutral, formed by the union of the separated portion of oxide with the remainder of the solution which is not decomposed. What is new in this labour is, the comparison of the properties of the nitrite of mercury with those of the nitrate. Almost all solutions contain more or less of the former of these salts. It is prepared by making nitrous gas pass into nitric solutions, which greedily absorb it. Super-oxidated nitrate absorbs much more of it than the nitrate little oxidated. The latter, nitrite of mercury,

cury, difengages a great deal of rutilating vapour by the fulphuric and nitric acids. It tinges the ſkin of a dark purple colour: while nitrate very much oxidated dyes it black, and nitrate little oxidated, like the nitrite of the ſame nature, does not change the colour of animal matters. It retains longer in the open air its nature of nitrite than the alkaline nitrites, which ſpeedily reſume the nature of nitrates. Alkaline nitrites, and particularly deliqueſcent nitrites, may be prepared without difficulty by impregnating the ſolutions of nitrates, &c. with nitrous gas, which eaſily condenſes in them.

The author, to terminate his labour, is to occupy himſelf with the muriates of mercury, of which he has diſcovered a new kind, and with the ſulphurets of the ſame metal. It would be a pity that the important and numerous functions entruſted to him, ſhould oblige him to diſcontinue theſe uſeful reſearches; but, happily for the intereſt of ſcience, people ſeldom abandon a career which they have long purſued with ſucceſs.

On Aluminous Sulphates.

S. Seguin, having been employed in continued reſearches on the different ſtates of the ſulphates of alumine, read on that ſubject a memoir, in which he proves That the acid ſulphate of alumine pure, that is to ſay when free from thoſe ſubſtances which it is neceſſary to add to it in order to make it cryſtallize, does not, in any caſe, decompoſe the muriate of ſoda—That alum, the cauſe of the cryſtallization of which is the ſulphate of potaſh, does not experience decompoſition from the muriate—That alum, the cauſe of the cryſtallization of which is the ſulphate of ammonia, receives no alteration from the muriate of ſoda, when it contains only the quantity of ſulphate of ammonia indiſpenſably neceſſary for its cryſtallization—Finally, that alum, containing more ſulphate of ammonia than the quantity neceſſary for its cryſtallization, is the only ſalt which experiences alteration by the muriate of ſoda; and that this alteration is confined merely to the decompoſition of the ſulphate of ammonia which it contains in exceſs.

A New Triple Salt.

There reſults from the decompoſition above mentioned, on the one hand muriate of ammonia, and, on the other, a triple ſalt, compoſed of ſulphuric acid, ſoda and ammonia, and which had not been before remarked.

A mixture either of the ſulphate of ammonia and muriate of ſoda, or of ſulphate of ſoda and ſulphate of ammonia,

S 2 produces

produces this triple falt in its full purity. In the firft of thefe two cafes, the affinity of the fulphate of ammonia for the fulphate of foda oppofes the total and generally admitted decompofition of the fulphate of ammonia by the muriate of foda. This triple falt acts a diftinguifhed part in the fabrication of fal ammoniac: it cryftallizes regularly; does not efflorefce in the air; has a favour, at firft pungent, then flightly bitter; is decompofed by foda, which transforms it wholly into fulphate of foda; decrepitates in the fire, fwells up in it, and fuffers to be difengaged, firft ammonia, and then acid fulphate of ammonia, while pure fulphate of foda remains at the bottom of the veffel.

A New Polifhing Rouge.

Chemiftry, which can contribute in fo effectual a manner to the improvement of the arts, does not lofe this important direction, and, in this refpect, defcends to the minuteft details. In confequence of a report prefented to the Clafs, on a *rouge* for polifhing, C. Guyton communicated fome obfervations on ochry reds fimilar to thofe of Almagra in Spain, and which, in many cafes, might be fubftituted for red oxide of iron or colcothar. He mentioned as a very œconomical procefs, and proper for giving the laft polifh to the hardeft matters, the ufe of bits of old hat, which, as is well known, are dyed with iron. By immerfing thefe pieces of hat for fome minutes in fulphuric acid, the iron which they contain paffes to the ftate of red oxide, and they then become excellent pieces for polifhing, and may be ufed in the ftead of the fineft rouge.

Analyfis of an Ore of Uranium.

C. Sage communicated to the Clafs the analyfis he made of a fulphurous ore of uranium, of a blackifh brown colour, without a regular form, and brought from Erbenfloch in Saxony.

This ore, which has fome external relation to that generally known under the name of *pechblende*, is however different in its colour, which is brownifh and dull, and in exhibiting fome pyritous points. It contains iron, the prefence of which was manifefted by the magnet, after the torrification neceffary to difengage the fulphur.

It refults from the different trials to which this fubftance was fubjected by C. Sage, that 100 parts of it contain 78 of uranium, 20 of iron, and 2 of fulphur.

Thinking, like all thofe who poffefs any elevation of mind, and a philofophical fpirit in cultivating the fciences,

that

that it is more proper to confecrate the names of men who have enriched them by their difcoveries, than thofe of the fabulous deities, and great men who refemble thefe deities in a great many points, C. Sage wifhed that the name of *uranium* given to this metal by the Germans, who call the planet difcovered by Herfchel *Uranus*, might be changed. In applauding thefe motives, it will perhaps be found that the names of celebrated men ought to be affigned to thofe things which have been the particular objects of their attention, and that Klaproth, who difcovered this metal, has a greater right than any other to diftinguifh it by his name. The French feem conftantly to agree in giving the name of Herfchel to the planet which he brought from that obfcurity under which it had been concealed for fo many ages; and, by the effect of the fame fentiment of juftice, the names of Piazzi and Olbers will undoubtedly remain to thofe difcovered by thefe aftronomers.

Zoologifts and botanifts now confecrate to their mafters and friends the genera or fpecies which they difcover; and mineralogifts no doubt will foon follow their example. The name of *Scheele*, fo juftly celebrated, has already been fubftituted for that of *tungften*.

ANATOMY.

Artificial Preparations in Wax.

The art of imitating anatomical preparations with wax, of little ufe when applied to objects eafy to be obtained by diffection, and which may be daily procured, fuch as thofe of the moft vifible parts of the human body, becomes important when applied to the reprefentation of things rare or difficult to be obtained, fuch as the different objects of comparative anatomy, or of things accidental and tranfient, as monftrofities and uncommon difeafes. In the laft place, it is almoft indifpenfable to make known to pupils certain parts of fuch a complex nature, that the demonftrator cannot develop the whole in one diffection.

It is to this laft clafs that we muft refer the lymphatic veffels. The fuccefs of injecting them is fo variable; the quickfilver employed for that purpofe is fo inconvenient, in confequence of the fluidity it retains; in a word, it is fo rare that it can be made to penetrate to the laft ramifications of thefe veffels, even in one limb, that it is only by repeating thefe operations for a long time, and on a great number of fubjects, that it has been poffible to become acquainted with the whole of this vafcular fyftem. Natural pieces, prepared

 with

with the greateſt care and ſucceſs, ſoon alter, becauſe the mercury abandons their upper parts to accumulate itſelf in the lower, the veſſels of which it dilates and ruptures. Young anatomiſts then cannot, without the aſſiſtance of the arts of imitation, acquire elementary notions on this object. The caſe is the ſame in regard to preparations of the nervous ſyſtem, though leſs difficult to be made from bodies, but which, by deſiccation, are ſoon rendered indiſtinct, and almoſt uſeleſs.

It has long been found that anatomical preparations, executed in wax, are thoſe which exhibit, in the cleareſt manner, the qualities of ſuch objects, namely, all their dimenſions and all their colours; while other imitations, ſuch as common ſculpture, engraving, and even painting, beſides that they are not of a nature ſo delicate as thoſe of wax, cannot expreſs, at the ſame time, theſe two orders of qualities. Hence this method has been excluſively preferred to all others, and has been employed to form collections already celebrated. But ſeveral of them, while they give us reaſon to admire the hand of the artiſt, leave room ſometimes for regretting that it was not directed by the anatomiſt familiariſed with all the details of diſſection.

The union of theſe two kinds of talents in the perſon of C. Laumonier, aſſociate of the Inſtitute, has given great merit to three pieces which he ſubmitted to the inſpection of the Claſs; namely, a lower extremity, in which he has repreſented the muſcles, the ſuperficial veins, the extremities of the arteries, and the lymphatic veſſels; a head, exhibiting the cranium open, and the brain covered on the one ſide by the dura and pia mater, and uncovered on the other. The face and neck are prepared in ſuch a manner, as to ſhow chiefly the facial nerve, the eight pair, and the cervical branches. Another head, open at the height of the orbits, preſents a ſection of the poſterior lobe of the brain, and a portion of the cerebellum, cut above its tentorium. It was prepared with a deſign to exhibit the origin of the great ſympathetic nerve, and more particularly the cavernous ganglion, diſcovered by the author, and deſcribed with all its communicating branches in the *Journal de Phyſique.*

Theſe pieces, executed by the order of government for the School of Medicine, form a continuation of others which have been depoſited there for ſome years, and which are not inferior in point of merit.

MEDICINE.

Chemical and Medical Experiments on the Diabetes Mellitus.

Life, that phyfical, mechanical, and chemical procefs, fo complex, exhibits in its aberrations, as in its perfect accomplifhment, phænomena which are as much interefting to the philofopher as the phyfician. It is under this double point of view that C. Nicolas, affociate member of the Inftitute, and profeffor of chemiftry in the central fchool of Calvados, and Dr. Guedeville, have confidered the *diabetes mellitus*, or the *pthyfuria faccharina.*

The prefence of the faccharine matter, which, for a long time, was found only in the fugar cane (*Arundo faccharifera*, Linn.), has, by the labours of modern chemifts, been difcovered not only in many other vegetable fubftances, fuch as the mallow, the juice of the maple, beet-root, &c. but alfo in the mineral kingdom, where C. Vauquelin has proved its exiftence by his analyfis of the emerald and aigue-marine. Some products of the analyfis of milk had fhown an analogy between it and fugar. Dr. Willis remarked, that, in the morbid affection in queftion, the firft fymptom of which is a fuperabundant evacuation of urine, this fluid affumed a fweet faccharine quality, inftead of the acrid and pungent favour which it has in general.

C. Nicolas and Dr. Guedeville, in the courfe of their practice, having met with patients attacked by diabetes, undertook a comparative analyfis of the urine voided in the diabetic ftate and in that of health. They afcertained, by careful experiments, the exiftence of the mucous faccharine matter in the former: they extracted from it acetous acid and alcohol, while in the fecond it is not fufceptible of fermentation, either vinous or acid.

The memoir of C. Nicolas and Dr Guedeville, which may be confidered as a complete treatife on the diabetes mellitus, contains a hiftory of the caufes afcribed to this difeafe, and the means employed to combat it fince the days of Hippocrates to the prefent time; and an exact defcription of the fymptoms it exhibits at its different ftages; the principal refults of their important labour on this difeafe, obfervations of which would be lefs rare were it not for the negligence of many phyficians, who commit into the hands of quacks and *urine doctors* the unfortunate patients attacked by it.

The principal caufe of the diabetes mellitus, which feems to be moft frequent in countries where cyder, or liquors of that kind, is drunk, is a fpafmodic and continual deviation

of the unanimalized nutritive juices to the urinary organ, which alters alfo the gaftric, pancreatic, biliary, &c. juices. It feems to be peculiar to mufcular temperaments. Its feat is placed in the fyftem of digeftion; and the urinary organ, by the excefs of its evacuations, fupplies the want of other excretions and fecretions which are fufpended.

The urine which paffes, as already faid, has the vinous and acetous fermentation, gives alcohol of a difagreeable odour, a cryftallized fugar, the nature of which is not yet well known, inftead of *urée*, uric and benzoic acid, which it ought to contain. Ammoniacal and phofphoric falts fhow themfelves in it only in very fmall quantity; the blood of phtyfuric patients is exceedingly ferous, and contains fcarcely any ammoniacal and phofphoric falts. Thefe phænomena furnifh the following indications:—

1ft. To remove the fpafmodic ftate.

2d. To reftore to the nutritive juices the principles of animalization.

And, to accomplifh thefe ends, to felect the food and remedies from fubftances which contain azot and phofphoric falts.

From thefe indications C. Nicolas and Dr. Guedeville have prefcribed to the fubjects of their different obfervations, an animal regimen, compofed of fat meat and milky beverages, in which phofphate of foda is diffolved. As medicines, they employed boles formed with an aqueous extract of opium and cinchona; fometimes alfo mufk. This treatment was attended with complete fuccefs *.

GEOLOGY.

Obfervations made on the Summit of Mont-Perdu.

The beauty of fites exhibited by mountains, and in particular the hope of reading on thofe awful maffes the hiftory of the revolutions which they feem to have witneffed, or at leaft of their refults, continually attract towards their fummits thofe who have once experienced the charm of thefe meditations, which might be called antediluvian.

C. Ramond, whofe particular ftudy it has been to make us acquainted with the Pyrenées, and particularly Mont-Perdu, has confirmed by a new tour, that this mountain overlooks all the furrounding peaks.

* Thofe who have feen Dr. Rollo's and Mr. Cruickfhank's valuable works on the Diabetes Mellitus, will be not a little furprifed to find them not even quoted in the preceding notice, though they prefent every one of the facts that have been noticed in it as new!——EDIT.

The

The ridge of it confifts of beds of black marble, filled with filiceous nodes, which here and there contain heaps of fhells, the fummit feems to have none of them, but they are found a little further down. Thefe beds or banks, which are generally parallel, follow the principle direction of the chain, and are fubject to flexions more or lefs confiderable on each fide of this direction. They are almoft all vertical, their mean inclination being about 80° to the fouth.

The cap of fnow which covers the peak is only about fix feet in thicknefs, becaufe the fteepnefs of the lateral declivities does not admit of its accumulation; but, in parts where the ground is lefs fteep, the thicknefs of the fnow is 40 or 50 feet, and it is more confiderable in the valleys, which catch the fnow as it rolls down from the furrounding declivities.

The fummit of Mont-Perdu prefented to C. Ramond two plants of the phanerogamia kind, the *Aretia alpina*, Linn., and the *Saxifraga retufas*, Gorian. Lower down he found the *Ceraftinum alpinum*, the *Saxifraga grœnlandica*, and the *Ranunculus pamaffifolius*. He is of opinion that it is not the height of the peak, but the want of earth proper for vegetation, that renders plants fo rare on the fummit. He faw fcarcely any thing but a few remains blafted by lightning and buffeted by the winds; and if, amidft this deftruction, occafioned by the combined action of the moft powerful meteors, a rock ftill in its place offered vegetables a firm fupport, it was covered by turf and plants in fuch a ftate of vigour, as proves that it is neither the want of air, nor the lownefs of temperature, that banifhes them from thefe regions.

The revolutions which this part of the globe has experienced appeared evidently to C. Ramond, to have been occafioned by the rending of the primitive mafs, the falient and re-entering angles of which are ftill fo entire and fo fharp, that he thinks if the caufe which disjoined them fhould operate exactly in a contrary direction, they would unite in fuch a manner, that the joining would be imperceptible.

Thefe characters, peculiar to the mafs of Mont-Perdu, "make it, fays Ramond, like an ifland of a few leagues in extent, raifed by fome revolution on the back of the Pyreneés."

GALVANIC SOCIETY, PARIS.

Dr. Nauche, prefident of the fociety, with the fenators Aboville and Lefpinaffe, has made a curious obfervation, which is of fome importance on account of the inferences that may be deduced from it. He has found that it is poffible to make a blind perfon, however great the degree of blindnefs, to perceive very lively and numerous flafhes of

light, by bringing one extremity of the voltaic pile into communication with the hand or the foot, and the other with the face, the ſkin, of the head covered with hair, and even the neck. There exiſts a line of demarcation, beyond which no flaſhes take place.

Dr. Nauche has alſo confirmed with his fellow labourers, Tourlet, Legallois, Bonnet, Douſſin-Dubreuil and Pajot-Laforêt;

1ſt. That reiterated applications of galvaniſm, when they comprehend the half of the trunk, produce in the perſon ſubjected to them great agitation, many reveries, involuntary tears, increaſed ſecretion of ſaliva, an acid or alkaline taſte, a great ſecretion of urine, an increaſe of heat and tranſpiration, abundant ſweat in the galvanized parts, great diſturbance in the ſtate of the pulſe, which is accelerated, and often imperceptible at the moment of the commotions.

2d. That the action of the galvanic fluid may be increaſed by drawing it off by a ſharp point, which does not appear to act at the moment of contact.

He has been able alſo to ſtimulate the organs ſeparately, by directing to the nervous trunks, which diſtribute themſelves to theſe organs, or which communicate with them, the two extremities of the pile, of the circle of cups or of the galvanic trough. He remarked that, by making the application a bath charged with a ſaline ſolution, a ſtrong *galvanic bath* may be obtained, the effects of which are mild, and ſometimes more advantageous than thoſe obtained by other proceſſes.

Paris, Dec. 17th.

In the laſt ſitting of the Galvanic ſociety, M. Robertſon repeated experiments on the combuſtion of phoſphorus and metals, by means of a very large pile compoſed of plates of copper and zinc. M. Gantherot announced that platina is a worſe conductor of the galvanic fluid than iron. Medical applications were not neglected, and among the uſeful reſults the following were mentioned: The cure of a gutta ſerena, with which a domeſtic of M. Gillet-Laumont, member of the council of the mines, had been affected, by M. Nauche, the preſident: of a ſciatica, on the coachman of the ſecond, by M. Dudanjeon; and of a palſy in the right arm, by M. Pajot-Laforêt. The ſociety appointed M. Laplace, Aboville, Leſpinaſſe, Suc, Dubreuil, Paroiſſe and Judelot, to make experiments at the national eſtabliſhment of the *Quinze-Vingts* on perſons born blind.

THE

THE BATAVIAN SOCIETY OF THE SCIENCES AT ROTTERDAM.

On the 21ſt of Auguſt, the ſociety propoſed the following new prize queſtions.

1ſt. What are the phænomena obſerved in regard to the origin and progreſs of waves, in laying the foundations of piers, at greater or leſs diſtances? What means have from time to time been diſcovered, and tried with more or leſs advantage to reſtrain or to leſſen the deſtructive conſequences of the courſe of the waves? What can be deduced from theſe phænomena, for explaining the cauſe of waves; and what uſe can be made of this knowledge, to improve the means already adopted for ſubduing the waves, or to render them more powerful?—To be anſwered before the 1ſt of March, 1804.

2d. What is the reaſon that the experiments in regard to the conducting power of bodies for caloric, are ſo uncertain and often contradictory? and what is the ſureſt and propereſt method to aſcertain the quantity of this conducting power both in ſolid and fluid bodies?—To be anſwered before the 1ſt of March, 1803.

The prize for each queſtion is a gold medal of the value of 30 ducats. The papers muſt be tranſmitted, poſt paid, under the uſual conditions, to the director and firſt ſecretary of the ſociety, Oliver Chriſtian Eickma.

THE JABLOWNSKY SOCIETY OF THE SCIENCES AT LEIPSIC.

This ſociety has propoſed the following prize queſtions for the year 1803.

Hiſtory.—An account of the connection which ſubſiſted between the kingdom of Poland and the grand Duchy of Lithuania, before and after the union eſtabliſhed by the aſſembly of the States at Lublin in 1569.

Natural Philoſophy.—Hiſtorical account of the theory of attraction, and the application made of it from the time of Newton to that of Laplace.

Economy.—What foreign trees and ſhrubs, uſeful on account of their ſpeedy growth, their duration, and their fitneſs for fire-wood; or applicable to the purpoſes of dyeing, tanning, or making furniture, can be cultivated and naturalized in the German pleaſure-grounds?

The prize for each will be a gold medal of the value of 24 ducats; and the papers muſt be tranſmitted, under the uſual conditions, to profeſſor Wieland at Leipſic, before the end of February, 1803.

ELECTORAL

ELECTORAL ACADEMY OF MENTZ.

This society have published a new volume of their transactions, 1799-1802, large octavo, with plates. The contents are, 1st. Chemical examination of some fossils, by Tromsdorff. 2d, Experiments on a proper method of preparing cinnabar in the dry way, by Buchenholzen. 3d. A view of the principles of the Derivation Calculus of the two French analysts, Lagrange and Arbogart, with a comparison between it and the Differential Calculus. 4th and 5th. Homeyer's essay, which obtained the academical prize. 6th. Observation on some rare kinds of fern, with three plates by Wildenow. 7th. On the *Asplenium*, and some plants of the same family, by Bernhardi. 8th. Observations on stripping off the bark of fruit trees as the means of increasing their produce. 9th. On the action of common saltpetre and common salt on animal bodies, by Thilow. 10th. Examination of the origin of harmony, and its progressive formation, with three plates. 11th. Stuffo, no deity of the Thuringians, by Wolf. 12th. Eloge of M. A. H. Frank, by Bellerman.

ROYAL ACADEMY OF SCIENCES AT BERLIN.

The following papers have been read before the Society since the commencement of the present year:—

Jan. 7. A continued account of the new planets, by professor Bode. 14. On the noble pride of men of letters, by the director de Castillon. 21. A paper on the question, To what extent were the antients acquainted with the art of painting? by counsellor Hirt. 28. A public sitting. M. Merian read the eloge of Mr. Selle; M. Teller, the eloge of M. von Wöllner; professor Bode, a history of the discovery of the new planets; professor Klaproth, an examination of the last experiments on galvanism.

Feb. 4. A chemical examination of the calculi found in the stomachs of horses. 11. On the certainty of the mathematical sciences, by professor Burja. 18th. A continuation of moral and philosophical thoughts, by M. Ancillon. 25. On the means of promoting mental culture in the ci-devant Poland, by M. Gedike.

March 4. A succinct account of the manner in which the vaccine has been introduced, brought into repute, and propagated at Vienna, by Dr. De Carena; read by M. Walter, junior. 11. Observations on the developement of the functions which contain multiple sines and co-sines of arcs. 18. On the oldest evidences of geology and physiology, and particularly men; by M. Trembley. 25. On some words of number, and their etymology; by M. Bastide.

April

April 1. Some observations on the cow-pock; by Dr. Hufeland. 8. On some elementary theorems of philosophy; by M. Gruson. 29. On the influence of the will; by M. Klein.

May 6. On the genealogy of the house of Prussia, 4th period; by M. Verdy. 13. An examination of the question, What is manuring? by M. Hermbstadt. 20. Experiments towards ascertaining the nature of some vegetable alkalies; by M. Bernoulli. 17. On improving the regulations in regard to criminals; by M. Zollner. 24. On the art of dressing; by count de Guyon.

July 1. A second memoir on artificial meadows; by M. Bastide. 8. Astronomical intelligence; by professor Bode. 15. Reflections and general principles in regard to manufactures and exclusive privileges; by M. de Castillon. 22. On synonyms, and the richness and elegance of languages; by the abbé Denina. 24. On the black gum of the elm-tree; by professor Klaproth.

Aug. 5. A public sitting. The eloge of M. de Carmer, and the eloge of M. de Moulines; by Dr. Merian. On the antiquity and riches of the German language; by the abbé Denina. On the organs of smell in man and in animals; by M. Walter, junior.

Sept. 16. Some remarks on the soul of man; by M. Prevost, of Geneva. Account of the new planet of Olbers; by professor Bode. 23. A fourth memoir on historical problems; by M. de Chambrier. 30. Geographical observations on the county of Hohenstein; by M. Gerhard.

XLIII. *Intelligence and Miscellaneous Articles.*

MEDICINE.

We copy the following article from an Edinburgh paper; it is an extract of a letter signed Civis:

"While I was at Smyrna there was a girl afflicted with a cancer in her lips, and the gum was affected. The European physicians consulted on the measure to be taken, and agreed that they saw no other method than to cut it out; and the girl had already submitted herself to that decision. By an accident of that nature which men cannot account for, an old Armenian came to them just in time to prevent the application of the knife. "Do nothing," said the Armenian, "I will cure her;" and when he had pledged himself strongly, the physicians consented. He procured a copper vessel

veſſel newly tinned in the inſide (an eſſential circumſtance) and having poured a certain quantity of olive oil into it, he made it boil over a ſmall fire, ſufficient to keep it gently agitated; and ſo for three times in twenty-four hours. With this the oil reſolved itſelf to the conſiſtency of an ointment, and, by conſtantly rubbing the part affected, he cured her in fourteen days.—Nothing elſe was done.

The phyſicians ſuppoſed that the oil received its virtue from the tin, and that it was communicated by its long boiling over the fire."

ON THE WEAVIL IN SEA BREAD.

The fatal effects of the weavil in ſea bread have long been ſeverely felt by ſeamen employed on long voyages: rewards have been humanely offered by the legiſlature for a cure or preventative, but hitherto without ſucceſs. The following fact was diſcovered by accident, and is now offered to the public as a hint worthy the attention of thoſe who may be employed in ſupplying ſhips with proviſions, or to captains and the owners of veſſels, and may, in all probability, leſſen, if not wholly remove, an inconvenience ſo injurious to our invaluable navigation:—A bag belonging to a powder-mill fell into a cauldron of liquid nitre; it was immediately taken out, plunged into cold water, and hung up to dry: ſeveral days after this circumſtance the bag was filled with ſea-biſcuit and ſent on board a Weſt Indiaman, where it was ſtowed away amongſt the captain's ſtock. The veſſel was nine months out of England before ſhe proceeded on her paſſage home, when ſhe got becalmed, and remained ſo long in that ſituation, that her crew were forced to be put on half allowance, more particularly ſo, as their bread was much deſtroyed by the weavils, and was hourly conſuming. The captain at this time wiſhing to make uſe of the bag above mentioned, which had not been opened ſince the ſhip left England, ordered it to be examined, when, greatly to his ſurpriſe, the whole contents were found to be perfectly ſound, without any appearance of having been injured by any inſect whatever; a circumſtance ſolely to be attributed to the quality of the bag.

ANTIQUITIES, &c.

A number of rare manuſcripts and other valuable articles have been brought to this country by Mr. Cripps, of Suſſex, and the Rev. Mr. Clarke, which we underſtand are principally intended to enrich the library of Jeſus college, Cambridge. The whole collection made by theſe gentlemen, illuſtrating

luftrating the natural and moral hiftory of the various people they vifited, in a journey from the 69th degree of north latitude to the territories of Circaffia and the fhores of the Nile, fills 183 cafes. The botanic part contains the herbary of the celebrated Pallas, enriched by the contributions of Linnæus, and his numerous literary friends. With the minerals are feveral new fubftances, and the rareft productions of the Siberian mines. Among the antiquities are various infcriptions and bas-reliefs, relative to obfervations made in the plain of Troy, and which were announced by M. Chevalier, in France, in the laft edition of his work. The medalic feries contains feveral coins of Greece, and of the kings of Parthia, hitherto unknown. The manufcripts are in Hebrew, Coptic, Arabic, Abyffinian, Perfian, Turkifh, and the language of Thibet Tartary: and in the Greek and Latin languages are feveral manufcripts of the claffics, of the gofpels, and the writings of the earlieft fathers of the church. In addition to thefe, the collection contains Greek vafes, gems, fculptures, and many remarkable Egyptian monuments, from the ruins of the city of Sais, difcovered by thefe travellers in the Delta after the evacuation of Egypt by the French: alfo numerous original drawings, maps, charts, plans, models, and feeds of many rare and ufeful plants; the habits, utenfils, idols, of the inhabitants of the Aleutan ifles, brought by Billings to Ruffia after his expedition to the countries lying between Kamtfchatka and the north-weft coaft of America, with many geographical obfervations, the publication of which was fo long withheld by order of the Ruffian government.

ON THE APPARENT ATTRACTION OF FLOATING BODIES. By a Friend to Phyfical Inquiries.

It is a well known fact, that when bodies which are afloat upon water come within a fmall diftance of each other, they will fuddenly rufh together: this fudden approach has ufually been attributed to a mutual attraction of the floating bodies; and it is common to float two cork balls in a veffel of water, for the purpofe of demonftrating this fuppofed attraction. A few years ago the following experiments were made, with a ftrong perfuafion that the abovementioned circumftance was not owing to the attraction of the cork balls; and if any one who is now of opinion that it is owing to a mutual attraction of the balls, will make the experiments themfelves, it is probable that they will have doubts on the fubject, or totally alter their opinion.

1. June 1797. Two cork balls (one larger than the other confiderably) were floated on water: when brought near

 each

each other, they approached in the uſual manner, as if by ſome mutual influence. This was expected.

2. The larger ball was ſtuck on a piece of wire, and was holden near the ſmaller one, which was floating whilſt this (the larger one) was entirely out of the water. There was, under theſe circumſtances, not any apparent attraction whatever.

3. The larger ball on the wire was then totally immerſed in the water, and, though near the other ball, there was not any apparent attraction.

4. The ball on the wire was then raiſed *partly* above the ſurface of the water near the floating ball; then the ſmall ball approached, and the uſual appearance of attraction took place.

The following is offered as an explanation of the above facts; and is ſuppoſed to be the chief, if not entire cauſe, of thoſe effects:

Round each cork ball, when floating on water, may be ſeen an elevated circular maſs of water, raiſed probably from the ſame cauſe (whatever that may be) by which water riſes in bread, ſugar, &c.: now it appears that when theſe two circular maſſes or rings of water touch each other they unite, and, by endeavouring to form one maſs, carry the two cork balls with them until they touch.

London, Nov. 2, 1802.

GALVANISM.

On the 20th of November profeſſor Aldini repeated, in two courſes, at Mr. Wilſon's anatomical theatre, Great Windmill-ſtreet, formerly that of the celebrated Dr. Hunter, the galvanic experiments which he performed before the French National Inſtitute, and lately at Oxford. The firſt courſe, deſtined for the medical ſtudents, was opened by Mr. Wilſon, who preſented profeſſor Aldini to his pupils, with ſome obſervations on his intereſting diſcoveries. The ſecond courſe, which commenced immediately after, was honoured by the preſence of his excellency general Andreoſſi, ambaſſador of the French republic, accompanied by ſeveral gentlemen of his ſuite; M. Argyropoli, charge d'affaires of the Ottoman Porte, Sir William Hamilton, Dr. George Pearſon, Dr. Lettſome, and a great many other gentlemen. Mr. Cuthbertſon aſſiſted the profeſſor in arranging the apparatus, and Mr. Hutchins, a medical pupil, provided the anatomical preparations. The experiments were performed with neatneſs and preciſion, and gave much ſatisfaction to the ſpectators, who teſtified their approbation by loud and repeated applauſes.

XLIV. *Analysis of the Schieferspath from Cornwall; to which is prefixed an Analysis of Carbonated Lime, and Remarks on the Means which have been employed to ascertain the Quantity of Carbonic Acid contained in it.* By Mr. RICHARD PHILLIPS, *Member of the British Mineralogical Society*.*

FROM some experiments made upon the schieferspath, I was induced to believe that it consisted of lime combined with a much greater quantity of carbonic acid than, according to the analysis of Bergman (Eng. edit. vol. i. p. 32.) is contained in carbonated lime. I refer to his analysis of this substance, supposing it to be the last, and perhaps the only one ever made of it, since it is quoted by Haüy, *Traité de Minéralogie*, tome ii. p. 128; and by Brochant, tome i. p. 548, as well as by other late writers on the subject. By the analysis of Bergman, pure carbonated lime consists of

Carbonic acid -	34
Lime - -	55
Water - -	11
	100

In order to ascertain the quantity of water, which, as above stated, is very considerable, the following experiments were made:

Exp. I. 100 grains of pure carbonated lime (double refracting spar) were exposed, in a silver crucible, to a red heat for about twenty minutes. On weighing them when cold they were found to have diminished 1·8 grain. It will hereafter be shown that a part of this loss was probably water: yet a portion of it is to be attributed to the disengagement of carbonic acid; for, upon putting the remaining carbonated lime into water coloured blue by syrup of violets, the solution instantly assumed a deep green colour. Hence it appears that this method is not to be relied upon in order to dissipate water only.

Exp. II. 400 grains of carbonated lime were introduced into a coated glass retort, having a receiver adapted to it. Soon after the application of heat, a very minute quantity of water appeared in the neck of the retort; but it was entirely dissipated before it had reached the mouth of it. Owing to this, and the extreme smallness of the quantity, it was entirely impossible to ascertain or even to estimate its weight. No more water appeared upon the application of a much stronger heat

* Communicated by the Author.

heat to the retort. This experiment was repeated with similar results.

Exp. III. To find the quantity of carbonic acid contained in carbonated lime, I made use of a vessel nearly similar to that described in * page 365 of the 12th volume of the Philosophical Magazine.

Into this vessel was put a sufficient quantity of nitric acid of the specific gravity 1·40, noting at the same time the aggregate weight of the vial, tube, and acid; and 100 grains of fragments of carbonated lime were gradually added to the nitric acid. When the last portions of it were decomposed, on weighing the vial, &c. it had received an addition of 56 grains. Hence 44 grains, which were carbonic acid, were expelled. On repeating this experiment with quantities of carbonated lime greater than 100 grains, proportional results were afforded.

Exp. IV. To determine the quantity of lime, 100 grains of carbonated lime reduced to powder were put into a platina crucible, and strongly heated in a wind-furnace for about two hours: the residuum was pure lime; it weighed 55·9 grains. Upon repeating this experiment I obtained a residuum weighing 55·05 grains. These results differ but little: their mean, 55·475, is therefore assumed as the quantity of lime contained in 100 parts of the carbonate.

According to the above experiments, carbonated lime contains

Carbonic acid	-	44
Lime	- -	55·475
Water and loss		·525
		100·000

In comparing the above with the analysis by Bergman there appears a difference of 10 of carbonic acid and nearly 10·5 of water. Kirwan, (Mineralogy, vol. i. p. 87.) on remarking the difference of the quantities of carbonic acid obtained by himself and Bergman, supposes the latter employed sulphuric acid to disengage the carbonic: and this conjecture seems well founded; for, if carbonated lime be put into sulphuric acid, the sulphate of lime formed, and falling down insoluble, so envelops a part of the carbonated lime that the complete action of the sulphuric acid is prevented: and as it does not appear that Bergman obtained the water by direct experiment, he seems to have assumed its quantity

* The experiments there related upon the satin spar were repeated; but it did not appear to contain more than the usual proportion of carbonic acid.

from

from the deficiency occaſioned by the incomplete action of the ſulphuric acid.

Still apprehending that reſults ſo diſſimilar might ariſe from inaccuracy in the method I had employed, more minute attention was paid to the diſengagement of the carbonic by the ſtronger acids. The following experiment was inſtituted to determine the quantity of muriatic acid carried over by the effervеſcence it excited. This acid was preferred to the nitric for two reaſons: being very dilute, and its action conſequently increaſed, the error is ſhown in its greateſt degree; and ſmall quantities of it are much more readily detected than of nitric acid.

Exp. V. 200 grains of fragments of carbonated lime were put into muriatic acid of ſpecific gravity 1·17 in the vial already mentioned, having a Woulfe's apparatus ſo adapted that the carbonic acid diſengaged might paſs through water. After the effervеſcence had ceaſed, the vial containing the muriate of lime was heated in water for nearly an hour, in order to expel the carbonic acid, which, although diſengaged from the lime, was held in ſolution by the water of the dilute muriatic acid. By theſe means the loſs was ·6 more than when nitric acid of 1·40 was uſed, occaſioned by the more rapid effervеſcence.

To the water through which the carbonic acid had paſſed nitrate of ſilver was added, which occaſioned the formation of ſuch a quantity of muriate of ſilver as, from comparing the degree of turbidneſs, was nearly equalled by ·6 of muriatic acid. The ſlight diſſimilarity evidently reſulted from the evaporation of the water of the muriate of lime by the heat employed to extricate the laſt portions of carbonic acid.

The ſtronger effervеſcence which a dilute acid excites, is not the only inconvenience attending it; the water is capable of combining with a quantity of carbonic acid, which renders it neceſſary to employ heat, as in the above-mentioned experiment, which is totally unneceſſary when a concentrate acid is made uſe of.

Analyſis of the Schieferſpath.

Some fragments of ſchieferſpath being put into muriatic acid, ſtrong effervеſcence took place, and nearly the whole was ſoon diſſolved: the ſolution was colourleſs; a very minute quantity of a finely divided white ſubſtance remained undiſſolved. The ſolution, divided into parts, exhibited with reagents the following appearances:

Pruſſiate of potaſh, a blue precipitate.

Tincture of galls, a dark brown precipitate.

 Ammonia,

Ammonia, a small quantity of reddish brown precipitate.

Oxalate of ammonia, a copious white precipitate.

Sulphuric acid and sulphate of soda both produced plentiful white precipitates; the latter not immediately: the solution, therefore, contained neither strontia nor barytes.

Carbonate of potash also occasioned a plentiful white precipitate: upon heating the solution after filtration no further deposition took place, as would have done had the solution contained magnesia.

The insoluble white residuum was boiled in sulphuric and nitric acids, but neither of them dissolved any part of it: potash dissolved it entirely: had it been alumina, its state of extreme division would have admitted of its easy solution in acids: it therefore appears to be silica. The same appearance took place with solution of the schieferspath from Germany.

From these preliminary experiments it appears that the schieferspath is a carbonated lime intermixed with oxide of iron and a very small quantity of silica; so small, indeed, that, had it not always appeared in every solution which was made of the foreign as well as the English, I should have been induced to suspect that its presence was rather accidental, than necessarily entering into the composition of the mineral.

Employing the method which has already been mentioned, 200 grains lost by solution in nitric acid of 1·40 specific gravity 86·8 grs. of carbonic acid, equal to 43·4 per cent. Now, according to the analysis just given of carbonated lime, 44 parts of carbonic acid are united to 55·475 of lime: hence 43·4 of carbonic acid must be combined with 54·718 of lime, forming together 98·118 of carbonated lime.

The nitric solution was considerably diluted with water, in order to effect more readily the subsidence of the silica; which being carefully collected, after repeated washing, and dried in a glass vessel by the heat of an Argand's lamp, weighed ·1 of a grain, equal to ·05 per cent.

The oxide of iron precipitated by ammonia was submitted to a red heat, and treated with carbonaceous matter so as to render it magnetic: on weighing, it was found equal to ·8 per cent. 100 parts consist of

Carbonate of lime -	98·118
Silica - -	·05
Oxide of iron - -	·8
	98·968
Loss - -	1·032
	100·000

XLV. *De-*

XLV. *Description of the Schieferspath.* *By* ARTHUR AIKIN, *Esq. Member of the British Mineralogical Society.*

SCHIEFERSPATH: Calcareus spathum schistosum: *Werner.* Argentine: *Kirwan.* Spath schisteux: *Brochant.*

Colour: very dilute yellowish white; by being kept for a few minutes in a red heat, it becomes slightly reddish white.

Lustre, internal; shining pearly.

Fracture: waved-lamellar.

Fragments: for the most part blunt-edged, wedge-shaped: it is translucid even when in mass, and at the edges is occasionally transparent. It is brittle; may be scratched by the nail, and has a slightly unctuous feel: specific gravity 2·740.

This mineral differs from common calcareous spar in its superior brilliancy; and especially in the total absence of the rhomboidal figure in its fragments. The specimen analysed*, and from which the above description was taken, differs from the general account of this mineral by Widenman, Emmerling, Brochant, &c. in being more transparent: it is probably from Polgorth tin-mine, and is covered in various parts with crystallized oxide of tin and chlorite: on breaking the specimen, a small quantity of fluor spar was found. It may be well to remark, that Cornwall, and probably the same mine, has produced a calcareous spar of the usual rhomboidal fracture and of a brilliant pearly lustre: it contains no silica, and appears to be lime combined with the usual quantity of carbonic acid and a little oxide of iron: specific gravity 2·723.

XLVI. *A short Account of Mr.* SMITH'S *Air-pump Vapour-bath.* *By Mr.* HENRY JAMES.

To Mr. Tilloch.

PERMIT me, Sir, to lay before the readers of your Magazine such an account of a *Philosophical Apparatus* (not less useful than ingenious) as may in some measure correspond with the general intention of so valuable a publication.

The *Air-pump Vapour-bath*, after fifteen years almost constant attention, and at a very considerable expense, has at length been brought to such a degree of perfection as to be applicable, with good effects, in some of the most distressing complaints to which suffering humanity is liable. The application of this apparatus is now at length committed to the direction of medical men, so that, I trust, its good properties will not, as heretofore, be overlooked; or, what amounts to the

* See the preceding article.

the fame thing, will not, from want of profeffional difcrimination, be fuffered to fink into oblivion. With this part of the bufinefs, not being a medical man, I have nothing to do: leaving it, therefore, in better hands, I fhall attempt, 1ft, Some account of its origin; 2dly, What, *à priori*, might have been expected from it in a philofophical point of view; and, laftly, Such an explanation of its principles as, I hope, may prove that it has a fair claim to its daily increafing popularity.

1ft. Mr. Smith, of Brighton, my father-in-law, from the ftory of king Edward, at the crufades, having had the poifon of an arrow fucked from a wound by the mouth of his fair queen, long ago conceived the idea of this Apparatus. His firft attempts at putting it in execution were rude, and almoft laughable: but the great engine of his mind, on this as on other occafions, rofe fuperior to all difficulties; and at length the accomplifhment of his object rewarded his perfeverance: for what will not perfeverance achieve!

With every poffible refpect for the faculty, may we not here take the liberty to exprefs our furprife that they fhould have left this extenfion of the powers of the cupping-glafs to be difcovered by an individual altogether unacquainted with the principles of their fcience? For the intelligent reader will prefently be informed, that the Air-pump Vapour-bath acts upon the fame principle as the cupping-glafs; and, to ufe the inventor's own words, "is neither more nor lefs than a cupping-glafs on a large fcale." This defcription is accurate as far as it goes; but Mr. Smith did not at the time take into account, that by means of his apparatus, fomentation can be applied, and its temperature regulated, with a degree of certainty and accuracy which, I apprehend, were never attained, or fo much as expected, before this happy difcovery. For I think it requires little fagacity to obferve, that in fomenting with flannels the temperature can never be for a minute equably preferved; but the limb muft be expofed to various degrees of heat and cold during the application.

2dly, To thofe of your readers who have vifited the tops of high mountains, it is unneceffary to defcribe the effects of the diminution of atmofpheric preffure. M. de Sauffure, who has publifhed an interefting account of his journey up Mount Blanc, ftates it moft forcibly. He found that the mercury in his barometer funk to 16 inches and a line (17·145 inches Englifh), and that the air had confequently little more than half the preffure of that on the plains. In fuch fituations, the arteries on the furface of the body, deprived of their accuftomed

tomed preffure, do not, as ufual, refift the impetus given to the blood by the contraction of the heart, which has been found to occafion difficulty of refpiration, violent retching, and even vomiting of blood.

I need not tell you, that the preffure of the atmofphere in its mean ftate is equivalent to a weight of 15 pounds to every fquare inch. It has thence been computed, that the preffure of the circumambient fluid upon the furface of the whole earth is equivalent to the weight of a globe of lead 60 miles in diameter. If every fquare inch of the human body, therefore, fuftains a preffure of 15 pounds, every fquare foot muft fuftain that of 2160 pounds; and according to this calculation, every ordinary fized man has to fupport a weight of between 15 and 16 tons for his common load. Such an enormous preffure, if not counterbalanced by the elafticity of the air within our bodies, would crufh us in a moment. If a portion of this preffure be removed from any part of the body, as is the cafe, for inftance, when a leg or arm is enclofed in the cylinder of this Apparatus, and the air partially extracted, the effect of this unequal preffure foon becomes perceptible to the patient. Should the exhauftion be carried to its utmoft extent, it requires no ftretch of imagination to conceive the effects that would be produced!

The quantity of atmofpheric preffure on the human body fometimes varies near a whole ton, from natural caufes. When it is diminifhed fo much, many people, particularly the nervous, find themfelves inactive and irritable. It is fomewhat furprifing that the fpring of the internal fluid, mentioned above, as counterpoifing atmofpheric preffure, fhould exactly balance it when artificially augmented, and even when naturally diminifhed, but not when *artificially* diminifhed. Thus, though we perceive no evident diftenfion of the blood-veffels on the furface of the body from the natural diminution of atmofpheric preffure; yet the cafe is widely different when the diminution is artificially produced, as can be effected to any extent within the cylinder of this Apparatus. Thus animals in the receiver of an air-pump become immediately uneafy, and can live but a very fhort time in air artificially deprived of no more of its preffure, than by the barometer, appeared to take place on the top of Mount Blanc. I am aware that this phænomenon may be accounted for on other principles; namely, that a certain quantity of oxygen gas diffufed through a given fpace, will not fuftain animal life half fo long as twice the quantity diffufed through the fame fpace. There may be fomething in this; but, I humbly think, it is not fufficient alone to account for

the immediate uneafinefs and early death of the enclofed animal.

What proportion of thefe confequences is to be attributed to retarding the impetus of the blood returning to the heart, and confequently producing an earlier collapfe of that organ, I leave to anatomifts and phyfiologifts to determine.

It was once the fafhion among phyficians to explain the functions of the human body by mechanical principles alone; to confider it as an hydraulic machine, and its fluids as afcending and defcending by the ordinary powers of fuch engines. From having applied the laws of dead matter to the functions of the living body too extenfively, they bewildered themfelves, and contradicted each other. Neverthelefs, in this age of perfected anatomy and improved phyfiology, we find Dr. Darwin, who is faid to have done as much for the latter fcience as fir Ifaac Newton did for natural philofophy, propofing "to ftill the action of the heart and arteries by mechanical means." This, he fuppofes, may be effected by fufpending a bed fo as to whirl the patient round, with his head neareft the centre of motion. For this purpofe, a perpendicular fhaft might have one end pafs into the floor, and the other into a beam in the ceiling, with a horizontal arm, to which a fmall bed might be attached. The effects of whirling a patient in this fituation, fo as by the centrifugal force to propel the blood from the fuperior into the inferior parts of the body, would certainly be confiderable, and, he obferves, might probably add to the means of curing fevers.

Be this as it may, the relief which many perfons have experienced from the ufe of the *Air-pump Vapour-bath*, authorizes me to affirm, that it is capable of producing, with eafe and fafety to the patient, all the good effects which Dr. Darwin could poffibly expect from his centrifugal machine.

It would neither be compatible with my attainments, nor your plan, to defcribe the medical ufes of the *Air-pump Vapour-bath*. I fhall therefore barely mention, that it has been found extremely beneficial in a variety of difeafes fpecified in a treatife lately publifhed, intitled, "Facts and Obfervations refpecting the Ufe of Smith's Air-pump Vapour-bath in Gout, Rheumatifm, Palfy, &c. &c."

Laftly, It only remains that I offer you fome explanation of the mechanical principles of the Apparatus, according to the references on the annexed plate.

Explanation of the Plate.

Fig. 1. (Plate VII.) a view of that end of the machine to which the exhaufter, &c. are affixed. A, the body of the machine.

machine. B the boiler containing the fluid, the fumes of which are thrown into the cylinder, through the ſtop-cock H, and heated by means of a ſpirit lamp C, which ought always to be withdrawn immediately on turning the ſtop-cock G, hereafter mentioned. D a thermometer, ſhowing the temperature of the fumigation. E the exhauſter for producing a partial vacuum within the cylinder, after the fumigation has continued a proper time. F the eſcape-valve of the exhauſter, to which a flexible pipe is adapted to convey the air from the chamber, if vitiated by the nature of the affection for which the application is made. G the ſtop-cock of the boiler. H another ſtop-cock to prevent the valves of the exhauſter from being injured by the hot fumes, as they enter the machine during the fumigation.

Fig. 2. a perſpective view of the machine from the other end, where the limb is admitted. I the body of the machine, made of ſtrong copper tinned in the inſide, ordinary tinned iron itſelf not being ſufficient, in all caſes, to reſiſt the preſſure of the atmoſphere. K the mouth of the machine, to which is attached a ſtrong bladder, cut ſo that one end of it may go over, and be firmly ſecured to it by means of a ligature; the other ſo that it may be drawn over the limb, when paſſed through it into the machine, and ſecured upon it by means of a roller.

The conſtruction of the machine juſt deſcribed, is adapted to the leg or arm only. Its principle, however, may be extended, and one might be made to include a greater portion of the body. Such an attempt is making. One of the moſt obvious conſequences of its application muſt be, a temporary expanſion of the veſſels of the part from whence ſo great a preſſure is removed. This muſt powerfully aſſiſt nature in removing obſtructions formed in them, which often ſpeedily produce inflammation, and terminate in ſuppuration and abſceſs.

Dr. Hamilton, of the London Diſpenſary, has obſerved, that the mode in which it muſt act is agreeable to ſound theory, and that the more it is applied to practice, the oftener will facts occur to recommend it. That eminent phyſician "not only views it as valuable to remove local affections of the extremities, but alſo to afford relief in other parts of the body, where obſtructions may have taken place." In the ſame letter he obſerves, that "the machine, by having a condenſing pump fixed to it, may be uſed as a bracer, and that with beneficial and powerful effects." This may be done merely by reverſing the valves in the pump.

Theſe

These confiderations, however, I fhall leave to your medical readers, to whom I wifh to fubmit this important query —*Is the application of the principle juft alluded to, ever likely to be of ufe in relieving the ruptured?*

No. 5, Cumberland Place,
New Road, Marylebone,
January 8, 1803.

I am, Sir, yours, &c.
HENRY JAMES.

XLVII. *Memoir on the Supply and Application of the Blow-pipe. By Mr.* ROBERT HARE *jun. Member of the Chemical Society of Philadelphia.*

[Concluded from p. 245.]

THE hydroftatic blow-pipe may be filled with any of the gafes, by exhaufting them from the inverted jars of the pneumato-chemical apparatus: and if it be defired to confine different fpecies of gas, by clofing the cock of communication between the compartments, one of them may be filled with one kind of gas, and afterwards, by turning the hood, the other compartment may be filled with another kind. To make this underftood, let *a*, fig. 5, be a pneumato-chemical tub, with a fhelf *c*, and an inverted glafs jar *b*. Suppofe that the tub were filled with water, and the jar with gas. Lute the pipe J, fig. 1, to the mouth of the fuction-pipe at I; pafs the fyphon L under the jar, as may be obferved in fig. 5, and then extend the bellows. The bellows will become filled with the air of the jar; and this being difcharged into that compartment of the cafk which is over the open fide of the hood, the bellows will be ready for another extenfion; the repetition of which would foon exhauft the jar of its air, although it fhould be of the largeft fize.

This method of filling the machine is very convenient in a laboratory well fupplied with pneumato-chemical apparatus. But it is a principal convenience of the hydroftatic blow-pipe, that it may be filled with any gas, immediately from the retort, bottle, or matrafs, made ufe of in obtaining it. Let D, fig. 6, be a feparate reprefentation of the pipe D, fig. 1. Let B be a matrafs containing the fubftance from which the air is to be obtained, and let C be a fyphon luted to the neck of the matrafs. The air iffuing from the matrafs muft be emitted from the mouth of the fyphon at the lower end of the pipe D. Suppofe that this pipe were in its proper fituation at D, fig. 1, the air iffuing from the matrafs would be difcharged

difcharged into that compartment of the cafk under which the mouth of the fyphon fhould be placed, and if the cock at Y fhould be clofed, this compartment alone would become filled; but if this cock fhould be open, the air would divide itfelf equally between both compartments. It muft be obvious, that while one matrafs and fyphon are employed in filling one compartment with one fpecies of air, the bellows, or another matrafs and fyphon filled with different fubftances, may be employed in filling the other compartment with another fpecies of air; and thus the oxygen, and hydrogen gafes or oxygen gas, and atmofpheric air, may at the fame time be confined in the fame veffel without their mixing with each other.

Thofe who defire to experiment largely with oxygen gas will find it advantageous to make ufe of a caft iron matrafs, with a fhort and large neck narrowing inwards, and about fifteen inches of a gun barrel. The neck of the matrafs being made large and fhort, it will not only be eafily filled, but will be readily freed from any caput mortuum which may be left in it. The gun-barrel muft be ground to fit the neck of the matrafs.

The fyphon for conveying the gas into the cafk may be fitted to the gun-barrel with a cork.

The philofophical world has been for fome time acquainted with the intenfe heat produced by combuftion fupported with oxygen gas. By means of the hydroftatic blow-pipe, every artift may, with little trouble and expenfe, avail himfelf of the intenfe heat produced by this combuftion *.

Probably there are not at prefent many operations in the arts which require greater heat than may be produced by the ordinary means; but it is certain that the knowledge of a procefs cannot precede an acquaintance with the heat neceffary to effect it; and this moft intenfe fire being placed within the reach of the artift, it is highly probable that cafes may be difcovered in which it may be applied with convenience and utility.

The moft convenient way of making ufe of oxygen gas for fmall operations, is to fupply one of the compartments of the hydroftatic blow-pipe with that gas; to retain the gas thus confined for thofe moments when the greateft heat is required; and, by means of the other compartment, to make

* In a former page I mentioned the gafometer of Lavoifier as being too complicated for ordinary application to the fupply of oxygen gas. I fhould alfo have noticed the apparatus of Sadler and the gafometer of Seguin; but, if I am not miftaken, thefe, although very ingenious inventions, are liable to the fame objection.

ufe of atmofpheric air when the heat produced by it is fufficiently intenfe. It muft be obvious, if the conical mouths, O, o, of the pipes M, N, O, m, n, o, fig. 1, be furnifhed with ftraight mouth-pieces, that any lamp or candle placed on the ftand TV may be readily fhifted from one mouth-piece to the other, when it fhall be defired to expofe any fubject fucceffively to the heat produced by atmofpheric air and oxygen gas.

If it be wifhed to make ufe of the heat produced in the combuftion of charcoal with oxygen gas; after having confined a fufficient quantity of this gas, it will be neceffary to fix in the conical mouth of the pipe, communicating with the compartment containing the gas, the larger end of a common brafs blow-pipe, the orifice being directed downwards. Under this orifice the body to be acted on muft be placed, fupported by a piece of charcoal, in the form of a parallelopiped, the charcoal being ignited in the part contiguous to the body. Things being thus arranged, by turning more or lefs the cock of the pipe in which the blow-pipe fhall be fixed, a ftream of oxygen may be precipitated on the burning fpot, with the proper degree of rapidity *.

This method of fupporting the combuftion of carbon with oxygen gas is nearly the fame as that by which the celebrated Lavoifier performed his experiments; excepting that in the place of the hydroftatic blow-pipe he made ufe of his gafometer.

In the introduction to this paper it was mentioned that fome experiments had been performed which feemed to invalidate the opinion that the employment of larger quantities of oxygen gas would be the only means of increafing the power of caloric. I fhall proceed to give an account of thefe experiments, but will firft retrace the ideas which led to them.

In operating with the combuftion of carbon and oxygen gas, great evils were obferved to refult from the difficulty of placing the fubject of the operation in the focus of the heat, without interrupting the ftream of air by which this heat was fupported. Not only was the focus widened by this interruption, and the intenfenefs of the heat thereby leffened; but the ftream of air oxidated thofe fubftances which were combuftible, and cooled thofe which were otherwife, in the places where it impinged previoufly to its union with the charcoal,

* In detailing the ufes of the hydroftatic blow-pipe, it may be proper to mention the facility which it gives to the employment of the gafes for medical purpofes. When this machine is filled with any gas, the bag to be made ufe of in refpiring it may be inflated by fixing it to the mouth of the pipe of delivery communicating with the gas.

Added

Added to this, the charcoal was ſo rapidly conſumed, that the ſubſtance acted on became ſo much buried, that it was difficult to follow it with the eye, or the orifice of the pipe: and ſome ſubſtances were obſerved to run into the pores of the coal, and elude examination.

To avoid theſe evils, it was thought deſirable that means might be diſcovered of clothing the upper ſurface of any body which might be ſubjected to this ſpecies of operation with ſome burning matter, of which the heat might be equal to that of the incandeſcent carbon, with which the lower ſurface might be in contact; or by which bodies might be expoſed on ſolid ſupports to a temperature equal or ſuperior to that of the porous charcoal uniting with oxygen.

It ſoon occurred that theſe deſiderata might be attained by means of flame ſupported by the hydrogen and oxygen gaſes; for it was conceived that, according to the admirable theory of the French chemiſts, more caloric ought to be extricated by this than by any other combuſtion.

By the union of the baſes of the hydrogen and oxygen gaſes, not only is all the caloric of the oxygen gas evolved, but alſo a much larger quantity, which muſt be neceſſary to give the particles of the hydrogen their ſuperior power of repulſion. The product of this combuſtion is water in the ſtate of ſteam, which retains heat ſo ſlightly, that it acts merely as a vehicle to deliver it to other bodies. What is neceſſary to preſerve to water its form of fluidity, is the only portion of the caloric extricated in this combuſtion, which is permanently abſtracted.

The combuſtion of carbon with oxygen gas has been hitherto conſidered as the hotteſt of all fires. The caloric evolved in this caſe proceeds from the oxygen gas alone, while the product of this combuſtion is carbonic acid gas, which abſtracts the large quantity of caloric, neceſſary to give it the form of permanent air, but which adds nothing to the heat of the combuſtion. Hence it is evident, that more caloric is evolved, and leſs abſtracted, in combuſtion ſupported by the hydrogen and oxygen gaſes, than in that ſupported by oxygen gas and carbon.

However, the intenſeneſs of the heat of combuſtion is not only dependent on the quantity of caloric extricated, but alſo on the comparative ſmallneſs of the time and ſpace in which the extrication is accompliſhed. But in this reſpect the aëriform combuſtible has obviouſly the advantage over thoſe which are ſolid, as its fluid and elaſtic properties render it ſuſceptible of being rapidly precipitated into the focus of combuſtion,

combuftion, and of the moft fpeedy mixture with the oxidating principle when arrived there.

The opinion of the intenfenefs of the heat produced by the hydrogen and oxygen gafes thus upheld by theory, derives additional fupport from the practical obfervation of the great heat of a flame fupported by hydrogen gas while iffuing from a pipe; and alfo of the violent explofion which takes place when it is mixed with oxygen gas and ignited; for it appears that this explofion can only be attributed to the combination of an immenfe quantity of caloric with the water which is either held in folution by thefe gafes, or formed by the union of their bafes.

Such was the reafoning which originated the defire of employing the flame of the hydrogen and oxygen gafes. But before this could be accomplifhed it was neceffary to overcome the difficulty of igniting a mixture of thefe aëriform fubftances without the danger of an explofion. It was for the purpofe of furmounting this difficulty that the hydroftatic blow-pipe was furnifhed with two compartments, by means of which the machine might be at the fame time charged with different fpecies of air, without any poffibility of mixture. One of thefe compartments being fupplied with oxygen and the other with hydrogen gas, two common brafs blow-pipes a, b, fig. 8, were joined at their orifices to two tubular holes in the conical fruftum of pure filver c, of which the mean diameter is one-third, and the length is three-fourths of an inch. The diameter of one of thefe holes is large enough for the admiffion of a common brafs pin. The other hole is a third lefs. They commence feparately on the upper furface of the filver fruftum near the circumference, and converge fo as to meet in a point at the diftance of a line and a half from the lower furface. In the fpace between the lower furface and the point of meeting, there is a perforation of the fame diameter as the larger hole. The manner in which this perforation and the tubular holes communicate one with the other, may be underftood from the lines in the form of the letter Y, in the tranfparent reprefentation of the filver conical fruftum at d. The pipes a b were then fitted into the mouths O, *o*, of the pipes of delivery, fig. 1; fo that the blow-pipe inferted into the larger hole of the fruftum fhould communicate with the compartment containing the hydrogen gas, and that the other fhould communicate with that which contained the oxygen gas. The cock of the pipe communicating with the hydrogen gas was then turned until as much was emitted from the orifice of the cylinder

as

as when lighted formed a flame smaller in size than that of a candle. Under this flame was placed the body to be acted on, supported either by charcoal or by some more solid and incombustible substance. The cock retaining the oxygen gas was then turned, until the light and heat appeared to have attained the greatest intensity. When this took place, the eyes could scarcely sustain the one, nor could the most refractory substances resist the other.

However, it is worthy of notice that the light and heat of this combustion do not become evident until some body is exposed to it, from which the light may be reflected, or on which the effect of the heat may be visible. This is not the case with combustion supported by oxygen and carbon; for no sooner is a stream of oxygen gas directed on ignited carbon, than an effulgence is produced, which impresses the mind of the beholder with an idea of the greatest heat being produced by it.

It is in this different appearance of these different species of combustion that we may discover the reason why philosophers have neglected the one, while they have bestowed much attention on the other *.

In lieu of the conical frustum represented at c d, that at d e may be used. The tubular holes of this last-mentioned frustum do not meet, but deliver their air, at separate orifices, into an excavation in the lower part of the frustum. The dotted lines represent the tubular holes, and the arched line the excavation. This is about three lines in diameter, and enters into the silver about the same distance.

At f are represented pipes which are used for the fusion of platina, or subjects of the larger kind. They consist of a large and a small pipe, the orifice of the one being inserted into that of the other, as may be understood from the dotted lines near f.

The purity of gases contained in the hydrostatic blow-pipe may be at any time examined by charging eudiometers from the syphon and leathern pipes hanging to the cocks ZZ, fig. 1. These cocks are soldered to curved pipes, one of which is represented in the figure. By turning the cocks round, the

* The inferiority of the light emitted by the flame of the hydrogen and oxygen gases, to that which irradiates from bodies exposed to its action, adds one to the many instances in combustion in which the quantity and colour of the light extricated do not seem to be so much dependent on the quantity of oxygen gas consumed, as on the nature of the substances heated or burned: In this, therefore, we may find support for the idea, that the light extricated by fire, or emitted by heated bodies, proceeds not only from the decomposition of pure air, but from that of the combustible, or the heated bodies themselves.

mouths

mouths of the curved pipes may be brought down to the ſurface of the water; this gives a facility to the diſcovery of any heavier gas which may be mixed with one which is more light, as the fluid, whoſe ſpecific gravity is greater, will be found on the ſurface of the water.

I ſhall now deſcribe the changes effected on the moſt fixed and refractory ſubſtances by the flame of the hydrogen and oxygen gaſes.

In order to avoid a tedious recurrence to an awkward phraſe, I ſhall generally, in the ſubſequent part of this paper, diſtinguiſh the flame of the hydrogen and oxygen gaſes by the appellation of *gaſeous flame.*

By expoſure to the gaſeous flame, either on ſupports of ſilver or of carbon, barytes, alumine, and ſilex, were completely fuſed.

The products of the fuſion of alumine and ſilex were ſubſtances very ſimilar to each other, and much reſembling white enamel.

The reſult of the fuſion of barytes was a ſubſtance of an aſh-coloured caſt, which after long expoſure ſometimes exhibited brilliant yellow ſpecks. If it be certain that barytes is an earth, theſe ſpecks muſt have been diſcoloured particles of the ſilver ſupport, or of the pipes from which the flame iſſued.

Lime and magneſia are extremely difficult to fuſe, not only becauſe they are the moſt refractory ſubſtances in nature, but from the difficulty of preventing them from being blown on one ſide by the flame: nevertheleſs, in ſome inſtances by expoſure on carbon to the gaſeous flame, ſmall portions of theſe earths were converted into black vitreous maſſes. Poſſibly the black colour of theſe products of fuſion may have been cauſed by iron contained in the coal; for in the high temperature of the gaſeous flame, a powerful attraction is reciprocally exerted by iron and the earths.

Platina was fuſed, by expoſure on carbon, to the combuſtion of hydrogen gas and atmoſpheric air. But the fuſion of this metal was rapidly accompliſhed by the gaſeous flame, either when expoſed to it on carbon or upon metallic ſupports.

A ſmall quantity of this metal in its native granular form, being ſtrewed in a ſilver ſpoon, and paſſed under the gaſeous flame, the track of the flame became marked by the conglutination of the metal; and, when the heat was for ſome time continued on a ſmall ſpace, a lump of fuſed platina became immediately formed.

About two penny-weights of the native grains of platina, when

when fubjected to the gafeous flame on carbon, became quickly fufed into an oblate fpheroid as fluid as mercury. This fpheroid, after being cooled, was expofed as before. It became fluid in lefs than the fourth of a minute.

Had I fufficient confidence in my own judgment, I fhould declare, that gold, filver, and platina, were thrown into a ftate of ebullition by expofure on carbon to the gafeous flame; for the pieces of charcoal on which they were expofed became wafhed or gilt with detached particles of metal in the parts adjoining the fpots where the expofure took place. Some of the particles of the metal thus detached exhibited fymptoms of oxidation.

As the fufion of lime and magnefia by expofure on carbon was accomplifhed with great difficulty and uncertainty, it became defirable that means might be difcovered of effecting this fufion with greater eafe.

By the union of the bafe of oxygen with iron, the whole of the caloric of this elaftic fluid is fuppofed to be extricated. This confideration, together with fome practical remarks on the heat of burning iron, induced me to employ the combuftion of this metal in conjunction with that of the hydrogen and oxygen gafes.

Some pieces of iron wire, each of about half an inch in length, were quickly thrown into fufion and rapid combuftion by expofure on carbon to the gafeous flame. When either lime, magnefia, barytes, alumine, or filex, were thrown on the iron in this ftate, they became inftantly melted and incorporated with the metal. It remains a queftion whether in this cafe the earths were fufed or diffolved, and whether the fubftances which refulted from their union with the iron were mixtures or combinations. If they were combinations, according to the prefent nomenclature, they fhould be denominated *ferrurets*.

The difficulty of igniting fome fubftances which are only fufceptible of combuftion at very high degrees of heat, has hitherto excluded them from the laboratory. By means of the gafeous flame, fuch fubftances may be employed with the greateft facility in fmall analytical operations.

Of the nature of the fubftances above defcribed are the carburets of iron and fome peculiar fpecies of native coal.

Among the carburets of iron, the Englifh plumbago is efteemed the beft. Some pieces of this fubftance, obtained from the beft Englifh black-lead pencils, were readily thrown into combuftion by expofure to the gafeous flame, either on carbon or on fome larger pieces of American plumbago. It was found that either lime or magnefia was fufible when

expoſed to the fire thus produced. This, however, may have been cauſed by the iron contained in the carburet; for the fuſed earths and plumbago generally adhered to each other.

There is a peculiar ſpecies of native coal found on the banks of the Lehigh in this ſtate, which it is extremely difficult to ignite; but when expoſed to a high degree of heat, and a copious blaſt of air, it burns, yielding an intenſe heat without either ſmoke or flame, and leaving little reſidue. By expoſure to the gaſeous flame on this coal, both magneſia and lime exhibited ſtrong ſymptoms of fuſion. The former aſſumed a glazed and ſomewhat globular appearance. The latter became converted into a browniſh ſemivitreous maſs.

The heat of the gaſeous flame is very much dependent on the proportional quantities of the gaſes emitted. On this account, the perforations in the keys of the cocks N, n, fig. 1ſt, ſhould be narrow and oblong, to admit of a more gradual increaſe or diminution in the quantity of gas emitted.

I have now concluded my communications on the ſubject of this paper, and ſhall be happy if they have been found worthy of the time and attention beſtowed on them by the ſociety.

XLVIII. *On the double Refraction of Rock Cryſtal, and another dioptric Property of that Mineral Subſtance. By* C. P. Torelli de Narci, *attached to the Council of Mines* *.

DOUBLE refraction, that ſingular property of rock cryſtal †, and of ſeveral other minerals, has long engaged the attention of mineralogiſts and philoſophers, though they employed it in no other manner than as a diſtinguiſhing character. C. Haüy ſays ‡: "It would be difficult to find a more ſtriking character than that deduced from double refraction, ſince it depends on the eſſence of the minerals in which it exiſts."

C. Rochon is the firſt philoſopher who employed this property of rock cryſtal to meaſure ſmall angles; and he read on the 26th of January and 9th of April 1777, to the Academy of Sciences, two memoirs on the application he made of it, and the exact reſults he obtained. This diſcovery muſt be of the greateſt utility, if means ſhould be found to conſtruct the inſtrument he invented at ſo moderate a price as to bring

* From the *Journal des Mines*, No. 66.

† Limpid hyalin quartz. Haüy *Traité de Mineralogie*, vol. ii. p. 427.

‡ Vol. i. of his Treatiſe, p. 254.

it

it within the reach of thoſe who might have occaſion to meaſure angles with it.

A deſire to accompliſh this object induced me to undertake ſome reſearches in regard to the cutting of rock cryſtal, and experiments on its double refraction, founded on thoſe made by Beccaria and Rochon. With rock cryſtal alone I formed *mediums doubly* refringent. This is the name which Rochon gives to theſe inſtruments cut cylindrically and compoſed of two or three priſms of this ſubſtance, which are perfectly achromatic, and produce very ſtrong double refraction. I conſtructed one with three priſms, in which the angle of double refraction is one degree eight minutes: and I find that larger may ſtill be obtained.

I ſhall not here indicate the direction in which I cut my different priſms of rock cryſtal in order to obtain the *maximum* of double refraction, becauſe I have ſtill ſome experiments to terminate before I can acquire a thorough knowledge of them. Among thoſe which I cut for my experiments, there is one which produces effects ſo ſingular that I think it my duty to deſcribe it.

This priſm, the ſection of which is an iſoſceles triangle, has one of its angles obtuſe, and of more than 100 degrees. When one looks through the two faces which form the obtuſe angle, and in a direction parallel to the face oppoſite to it, the object appears neither diſplaced nor ſenſibly coloured, but only inverted in ſuch a manner, that what is on the right appears on the left; and *vice verſa*. If a capital L, for example, cut out and applied to the pane of a window, be looked at, the horizontal line of that letter, inſtead of being on the right below the vertical one, appears to be ſituated on the left. By continuing to look at this letter, if the priſm be turned on itſelf, and in ſuch a manner as if it were traverſed by an axis parallel to the direction in which the letter is viewed, the image of the letter turns at the ſame time as the priſm; but it moves twice as quick—ſo that, if the priſm makes one turn, the image of the letter makes two. I made other very ſingular experiments with this priſm; but as it would be too tedious to detail them here, I ſhall reſerve them for a memoir, in which I ſhall explain the means I employed to aſcertain the rules which muſt be followed to cut rock cryſtal in the direction that produces the *maximum* of its double refraction, and to be able to conſtruct, without repeated trials, the inſtrument invented by Rochon, to meaſure, with very great preciſion, diſtances of every kind. I ſhall treat of its application to mines; and ſhall deſcribe the

 method

method I purſued to meaſure the deepeſt wells and the longeſt galleries.

I ſhall conclude this note with a ſuccinct account of ſome experiments which I made with the iſoſceles priſm of rock cryſtal already mentioned. By applying it to a ſimple *camera obſcura*, the objects painted in an inverted poſition, when this priſm is not uſed, are made to appear in their proper ſituation. By adapting it to aſtronomical teleſcopes, the ſame effect will be produced in regard to objects, which, when ſeen through the two convex glaſſes that compoſe it, appear inverted.

This priſm ſupplies the means of ſhortening teleſcopes deſtined to view terreſtrial objects, becauſe, by employing it with a convex eye-glaſs only, and an object-glaſs ſimple or achromatic, inſtead of three, four, ~~or five~~ eye-glaſſes, objects which without its interpoſition would have appeared inverted, will be ſeen in their proper poſition. By theſe means, one, two, three, or even four eye-glaſſes would be ſaved, and the teleſcope might be ſhortened by nearly the whole length occupied by theſe eye-glaſſes. Light alſo will be gained; for this priſm occaſions no loſs in this reſpect, the matter of which it is formed being exceedingly tranſparent; nor will any thing be loſt in regard to diſtinctneſs; for, as the priſm is very near the eye, the faults which might ariſe from any inexactneſs in the poliſhing of its two ſurfaces will not be ſenſible.

In employing this teleſcope it muſt be remembered, that at the ſame time that it inverts objects by turning them upſide down, it turns them from right to left, and what appears on the right in the field of the teleſcope is really on the left: for example, if a man going from right to left be viewed with it, he will appear in the teleſcope as if going from left to right, but in his natural ſituation: whereas, if viewed with the ſame teleſcope, taking from it the priſm of rock cryſtal and leaving only the eye-glaſs which inverts the objects, the man would appear not only to be proceeding in a direction contrary to that in which he really is advancing, but he would appear alſo inverted—the common effect of teleſcopes which have only a convex eye-glaſs.

Experience alone can ſhow whether this method of ſhortening land teleſcopes can be as uſeful as it appears curious, and whether it will be poſſible to conſtruct one at ſuch a moderate price as to maintain a competition with common teleſcopes, without which this inſtrument would remain among the number of thoſe diſcoveries which are rather curious than uſeful.

XLIX. *Pre-*

XLIX. *Preparation of the Phosphuret of Lime.* By J. B. Van Mons *.

PHOSPHURET of lime affords to the amateurs of amusing chemistry a curious compound, on account of the property it has of disengaging, when a few bits of it are thrown into water, a quantity of gaseous bubbles, which, on reaching the surface of that liquid, inflame spontaneously with a beautiful white flame, and give rise to successive detonations, which may be compared to a running fire of musketry. But the preparation of this phosphuret is often unattended with success on account of the air, which, by following the usual process, cannot be excluded from the vessels, and which oxidates and even acidifies the phosphorus; in which case, the combustible losing its action on the water, no detonating gas is engendered; and the correction, by which the inconvenience of oxidation is avoided, by putting the phosphorus at the bottom of the vessel, and the lime at the top, does not give a homogeneous product, but a saturated phosphuret, by the vaporization of the phosphuret, which brings it to a state improper for uniting itself with the lime. These different obstacles may be avoided by proceeding in the following manner:

Fill a small glass matrass, with a flat bottom and a long narrow neck, two-thirds, with one part of carbonated lime (white marble, washed chalk, or prepared oyster-shells). Place the matrass in a sand-bath, and apply a heat capable of expelling the carbonic acid from the lime. When you think that the decarbonization is near an end, introduce in portions a third part of phosphorus, at very small intervals, and constantly maintaining the matter at a dark red heat. The phosphorus fused, and prevented from burning by a remainder of carbonic acid gas which is disengaged from the lime, diffuses itself throughout the whole mass of the matter, contracts an union with the lime, loses its volatility, and forms phosphuret. After the whole phosphorus is introduced, let the fire be suddenly slackened, and stop the matrass with a stopper having a pneumatic valve to prevent access of the air, and to suffer to escape the gas which the matter that remains some time puffed up continues to disengage. When the matter is sufficiently cooled, take it from the matrass, and put it, taking care not to touch it with the

* From *Journal de Chimie et de Physique, par* J. B. Van Mons, No. 7.

fingers

fingers or other moiſt bodies, into heated glaſs flaſks which can be hermetically cloſed.

The phoſphuret of lime, when well prepared, is a compact maſs of a pale reddiſh brown colour inclining to chocolate. It inflames by the leaſt humidity, and emits in the air an odour of garlic mixed with that of phoſphorated hydrogen gas.

The ſame phoſphuret may alſo be prepared directly from lime, by directing, by means of a gaſometer with a column of water, through a hole formed in the belly of the matraſs, on the red matter, at the moment of adding the phoſphorus, a delicate current of carbonic acid gas.

L. *Chemical Analyſis of an uncommon Species of Zeolite.* *By* ROBERT KENNEDY, *M.D. F.R.S. F.A.S., and Member of the Royal College of Phyſicians, Edinburgh**.

THE zeolite ſubjected to the following experiments poſſeſſes ſome of the diſtinguiſhing properties common to other ſtones of the ſame claſs, but differs in certain reſpects from any variety with which I am acquainted. I found it, more than three years ago, in the baſaltic rock on which the caſtle of Edinburgh is built; and it was incloſed within a maſs of prehnite.

The colour of this zeolite is in ſome parts nearly white, in others grayiſh white. It is compoſed entirely of ſtraight fibres arranged in bundles or maſſes of different ſizes, all the fibres of each maſs converging towards a common point. The whole ſpecimen is an aggregate of theſe maſſes, the baſes of which are in contact with the prehnite, and are impreſſed with the form of its ſurface, which is rounded or botryoidal. The croſs fracture preſents the irregular and ragged ends of the broken fibres, termed the *hackly* fracture by Mr. Kirwan.

Although the ſhape and arrangement of the fibres appear plainly to be the effects of cryſtallization, yet I have not been able to trace a perfectly regular, determinate form in any of them. However, when the ſtone is broken, ſome of them can be readily ſeparated longitudinally, in a pretty entire ſtate, and ſeem in moſt inſtances to be four-ſided and rectangular. Their length is from half an inch to two inches; but their thickneſs does not exceed 1-40th or 1-50th part of an inch. None of theſe fibres can be broken acroſs, ſo as to

* From the Edinburgh Tranſactions, vol. v.

preſent

present an even surface; for they break irregularly, and become divided at the point of fracture into very minute spiculæ, which also assume a somewhat rectangular shape.

The small spiculæ or fibres are transparent and colourless, with a considerable degree of lustre; but the unbroken part of the stone possesses less lustre than the separate spiculæ, and much less transparency, from a want of compactness, and from the effect of many minute cracks.

Its hardness is not easily determined, on account of brittleness; but when a piece of it is rubbed against glass, though the fibres crumble down very quickly, yet the glass is slightly scratched at the same time. Small fragments of it can be broken with the fingers, or crushed by pressure, into very slender spiculæ, which are sharp, and apt to penetrate the hands when touched. Although the cohesion of its component parts be so weak, yet it bends, and yields in some measure before it breaks, and is not easily ground to powder in a mortar.

I found the specific gravity of different pieces of the specimen, taken in distilled water at the temperature of 60°, to vary from 2·643 to 2·740.

This stone has the property of appearing luminous in a dark place, both by friction and by heat. A very slight degree of friction produces this effect; for a person can easily distinguish a phosphoric light, even if he draws his finger across it. When struck with a hammer in such a manner that small fragments are driven off, they appear luminous in passing through the air, and continue to shine for a moment after falling on the ground; and a hard body drawn over it leaves a track of light, which remains a second or two visible. When a piece of the stone is pounded quickly in a mortar, a strong light is emitted; but after being wholly reduced to powder, it no longer shines.

The light which it gives by slight friction, is fully equal to that produced by two quartz pebbles rubbed or struck against each other strongly.

Small fragments of this zeolite placed on a piece of hot iron or of clay, also become luminous, and shine with nearly as much brightness as common blue fluor does, when heated in the same manner. By being made red-hot, however, it is deprived of the property of giving light afterwards by heat, though it still appears faintly luminous by friction. In all these experiments it is a reddish white light which it emits, accompanied at times with reddish momentary kind of flashes.

It can be melted without difficulty into glass. When a

ſmall piece of it is heated gradually with the blow-pipe, it firſt becomes white and opaque; a number of fiſſures are then formed, by which its bulk appears ſomewhat increaſed; and after the flame is made ſufficiently intenſe, it melts into a globule of colourleſs glaſs, the tranſparency of which is imperfect on account of many minute air-bubbles. Although thus fuſible by ſtrong heat, yet a very low degree of ignition ſcarcely affects it. A piece of the ſtone, after having been put into a crucible, and expoſed for a ſhort time to a fire which made it juſt viſibly red-hot, was not altered in appearance, and had not loſt more than $\frac{1}{200}$th part of its weight. In a temperature, however, about 20° of Wedgwood, I found that a fragment of this zeolite became opaque, and more eaſy to pulverize than in its natural ſtate; at 90° it did not melt, but was glazed on the ſurface, adhered to the crucible, and had begun to ſink down; and at 120° melted into an imperfect glaſs of a light greeniſh yellow colour, deficient in tranſparency, which acted ſtrongly on the crucible.

In temperatures ſufficiently high, it loſes from $4\frac{1}{2}$ to 5 per cent. of its weight; but to produce this effect, the heat muſt be equal at leaſt to 20° or 25° of Wedgwood. Part of the volatile matter thus driven off, is carbonic acid; for the zeolite, when reduced to powder, and mixed with acids, produces a ſlight efferveſcence. I found, by three different experiments, that the loſs of weight after the efferveſcence was about 3 per cent.; conſequently, the remaining 2 or $2\frac{1}{2}$ parts may be preſumed to conſiſt of moiſture.

This ſubſtance produces a jelly, as moſt other zeolites do, with the ſtronger acids. When ground to powder, and mixed with the ſulphuric, nitric, or muriatic acid, the mixture becomes a firm jelly in a few minutes, provided the acids are not much diluted, or uſed in too great quantity. That which is formed by the action of the nitric or the muriatic acid, is nearly tranſparent; but the ſtone contains ſo much lime, as will preſently be ſhown, that with the ſulphuric the jelly is white and opaque, on account of the ſulphate of lime which is generated.

The prehnite in which it was incloſed, as already mentioned, is of a light green colour, with ſome luſtre, and a conſiderable degree of tranſparency. It gives fire with ſteel, can be readily melted with the blow-pipe, and froths up much before fuſion.

Having made theſe preliminary experiments reſpecting the general properties of the zeolite, I ſubjected a portion of it, in the next place, to analyſis, to aſcertain of what earths it was

compoſed,

composed, and found that it consisted almost wholly of silex and lime, with a certain proportion of soda. The following were the methods by which it was analysed:

1. One hundred grains, reduced to fine powder in a mortar of flint, were mixed with 500 grains of muriatic acid and 1000 grains of distilled water. The powder was immediately attacked by the acid; some heat and momentary effervescence were produced, and in a few minutes the silex appeared floating in a loose and very divided state. The mixture being heated on a sand-bath, became in a short time a thin transparent jelly. I exposed this jelly to a gentle heat (less than 200° of Fahrenheit) till it became nearly dry. Water was then poured on it, and the mixture, after being digested for some time, was filtered. The undissolved part collected on the filter, when sufficiently washed, was dried and heated red-hot for a quarter of an hour. It weighed $51\frac{1}{2}$ grains, was perfectly white, and proved on examination to be pure silex, unmixed with any other earth.

2. The filtered solution, which was transparent and nearly colourless, after being saturated with caustic ammonia, deposited a small quantity of a brownish white precipitate. Having collected this precipitate on a filter, and washed it, I exposed it for a few minutes to a red heat. It then weighed one grain, and had become brown, and was found to consist of half a grain of oxide of iron, and half a grain of argil.

3. In the next place I added a few drops of sulphuric acid to the solution, to discover if it contained any barytes or strontian. The acid produced no precipitate. The solution was then evaporated to a small quantity, and boiled with carbonate of ammonia. Some carbonate of lime was thrown down, which, after being washed, and exposed for a few minutes to a very low red heat, weighed 57 grains. To drive off the carbonic acid, and ascertain the real quantity of lime which this precipitate contained, I put it into a small crucible of Cornish clay, which was inclosed within a Hessian crucible, and heated it for three hours. The fire was raised slowly at first, but was afterwards increased to 80° of Wedgwood. The lime adhered slightly, and weighed $31\frac{1}{2}$ grains. By treating it with sulphuric acid I detected some slight traces of magnesia, the rest being wholly converted into sulphate of lime.

4. The different earths having been thus separated from the solution, it was evaporated to dryness for the purpose of obtaining the soda, which I had learned by previous experiments would be wholly taken up with the other soluble parts of the zeolite, when decomposed by acids. After the evaporation

poration a white falt remained, which was heated gradually in a crucible to volatilize the muriate of ammonia formed in the courfe of the analyfis. When white vapours ceafed to rife, the heat was increafed to rednefs, and a falt was left which weighed 17 grains. On rediffolving it in a fmall quantity of water, and boiling the folution with carbonate of ammonia, a minute portion of carbonate of lime was precipitated, which weighed one grain; equal to about half a grain of pure lime. I obtained the falt by a fecond evaporation; and after it had been expofed again to a very low red heat, it weighed 16 grains, and confifted wholly of muriate of foda.

According to Mr. Kirwan's experiments, 16 parts of muriate of foda in cryftals contain 8·5 parts of foda; but the 16 parts above mentioned, by having been dried in a red heat, and confequently freed from water of cryftallization, would contain fomewhat more than 8·5 parts of foda. However, the proportion of foda in 100 parts of the zeolite may be ftated at 8·5 parts, which, though probably rather lefs than the real quantity, muft be very nearly correct.

Having finifhed the experiments juft defcribed, I analyfed the zeolite a fecond time; and made ufe of nitric acid, for the purpofe of afcertaining whether any muriatic acid entered into its compofition. By the teft of nitrate of filver, I found that fome traces of the muriatic acid could be diftinguifhed, although the quantity was very fmall. With regard to the proportion of the earths, the refults of the fecond analyfis correfponded almoft exactly with the former.

I alfo expofed fome of the zeolite to the action of the fulphuric acid in the following manner, with the view of obtaining the foda only, the earths being difregarded. One hundred grains *, reduced to fine powder in the flint mortar, were mixed with 250 grains of fulphuric acid, diluted with twice its weight of water. Some heat and very flight effervefcence were produced, and the mixture foon became thick and gelatinous. It was then evaporated flowly to drynefs in a fand-bath in a cup of Chinefe porcelain; and the dry mafs was pulverized and boiled for half an hour with water, and filtered. Having wafhed the undiffolved refiduum fufficiently, I boiled the filtered folution with carbonate of ammonia, which precipitated fome earthy matter. After this had been feparated by filtration, the folution was evaporated to drynefs

* I made ufe of fmall quantities only of the zeolite in all thefe experiments; becaufe, as the fpecimen appears to be the only one of the kind which has been found, I wifhed to preferve as much of it entire as poffible.

by

by a gentle heat; and the saline mass left was put into a crucible, and heated slowly to redness. A white salt remained in the crucible, which weighed 19 grains. To free this salt from any remains of earthy salts which might be mixed with it, I dissolved it in a small quantity of water, added some carbonate of ammonia, and boiled the mixture for a few minutes, by which means a slight earthy precipitate was thrown down. This being separated as before, the salt was again collected by evaporation, and heated to redness. It now weighed $17\frac{1}{4}$ grains, and was found on examination to be pure sulphate of soda *.

By Mr. Kirwan's estimation, $17\frac{1}{4}$ parts of dry sulphate of soda contain nearly eight parts of alkali; consequently, from 100 parts of the zeolite there have been obtained by the process last described eight parts of soda. This result corresponds with the former, in which the alkali was collected in the state of muriate of soda, as nearly as can be expected in such experiments; and it must be remembered, that the proportions of the component parts of neutral salts are not ascertained with precision.

According to the different experiments now detailed, 100 parts of this zeolite contain,

Silex (No. 1.) - - - -	51·5
Lime (No. 3 and 4.) - -	32
Argil (No. 2.) - - -	·5
Oxide of iron (No. 2.) - -	·5
Soda, about - - - -	8·5
Carbonic acid and other volatile matter	5·
	98·

with some traces of magnesia and muriatic acid.

The stone which has now been described resembles some of the varieties of tremolite mentioned by Saussure †, in the property of giving a phosphoric light by friction. Its specific gravity also is somewhat greater than that of the ordinary kinds of zeolite, as stated by mineralogists. Excepting in these particulars, however, it has the principal characters of a zeolite;

* The experiments which showed that soda was the alkaline basis of this salt, have not been stated here; because I formerly gave a description of the methods used in examining the same salt, in the paper on whinstone and lava, published in part 1. vol. v. Edinb. Transac. To avoid unnecessary repetition, I beg leave to refer to that paper, both with regard to the manner in which I endeavoured to determine the purity of the saline matter, and also that of the silex and some other earths.

† Voyages dans les Alpes, 1923.

a zeolite; for example, in its internal composition, in having been found in a whin rock adhering to prehnite, and in producing a jelly with acids. Tremolites have a higher specific gravity than this stone, are more infusible, and are considerably different in their composition *. Besides, such kinds of tremolite as I have examined cannot be decomposed by acids even when boiling, and must be heated with potash or soda before their component parts can be separated; but the substance in question is completely decomposed by acids, like the greater number of zeolites, in a very few minutes, and without the assistance of heat. For these reasons it appears to me to be a zeolite.

LI. *Experiments respecting the Action of some lately discovered Metals and Earths on the Colouring Matter of Cochineal. By* M. Hermstaedt †.

TO prepare the cochineal for these experiments, two ounces of Mexican cochineal of the first quality, being reduced to fine powder, were boiled in a tin bason with 74 ounces of distilled water. The liquor was then filtered and measured: it had lost two ounces by evaporation. It was then divided into portions of $2\frac{1}{2}$ ounces for each experiment.

A piece of kerseymere dipped in this tincture when taken out was of a lilac colour.

Exp. I. A saturated solution of very pure cobalt in nitric acid was dropped into a portion of the tincture of cochineal. The tincture became very clear, assumed a yellowish red colour, but remained diaphanous. After twelve hours there was deposited a precipitate of a sulphur-red colour; which, however, was in such small quantity that it was impossible to collect it.

Exp. II. Part of the solution of cobalt in nitric acid was diluted with water heated to ebullition in a glass vessel, and kept boiling for three minutes, with a piece of kerseymere 24 inches square. The kerseymere thus prepared being then immersed in the warm tincture of cochineal, immediately assumed a saturated bright red colour, leaving the tincture

* Kirwan's Mineralogy, vol. i. p. 278. Traité de Minéralogie par Haüy, tome iii. p. 151 and 227.

† From Scherer's *Allgemeines Journal der Chimie*, January 1802.

colourless,

colourless. The stuff, after it was washed and dried, retained a bright *mordoré* colour.

Exp. III. A neutral solution of cobalt in sulphuric acid was added to the tincture of cochineal. The tincture assumed a darker colour, and a violet precipitate was deposited. A piece of stuff impregnated with this solution of cobalt, and then dipped in tincture of cochineal, acquired a saturated violet colour.

Exp. IV. A neutral sulphuric solution of uranium gave with tincture of cochineal a precipitate almost black; but when a piece of stuff was dipped in the same solution, and then dyed with tincture of cochineal, it assumed a very agreeable grayish colour inclining to green.

Exp. V. A solution of cobalt in nitric acid, treated in the same manner, gave the same results; but with this difference, that the colour on the stuff was a little brighter.

Exp. VI. Fifteen grains of tungstic acid were put into a glass vessel, and six ounces of distilled water being poured over it, the whole was reduced by evaporation to four ounces. The solution assumed a turbid aspect, and a blueish white colour. A part of this solution being poured into tincture of cochineal, communicated to it a bright violet colour. A piece of kerseymere, being boiled for three minutes in this solution, was immersed in the warm tincture of cochineal: when taken out it was of a bright *ponceau* (poppy) colour.

Exp. VII. Fifteen grains of concrete molybdic acid were dissolved in water as above. It dissolved entirely, and the solution became clear and transparent. Being dropped into the tincture of cochineal, a dark violet precipitate was obtained. A piece of kerseymere boiled in the acid solution assumed a colour approaching to bright green, which, when the stuff was dried in the sun, passed to a gray inclining to bright blue. A piece of kerseymere impregnated with the same solution, being immersed in warm tincture of cochineal, assumed a very agreeable violet colour.

Exp. VIII. Arsenic acid, being mixed with the tincture of cochineal, the dark red colour of the latter was transformed into yellowish red, but without any deposit being formed. A piece of kerseymere was then boiled for three minutes in a very dilute solution of the same acid, and the stuff thus prepared was immersed in warm tincture of cochineal. The stuff immediately assumed a bright scarlet colour inclining strongly to yellow. Drying, and, in particular, pressing with a hot iron, made this colour lose a little of its brightness, and caused it to become darker.

Exp. IX. A solution of arseniate of soda slightly acidulated was applied as a mordant to another piece of kerseymere, and by immersion in tincture of cochineal a dark *mordoré* colour was obtained.

Exp. X. The same was repeated with alkaline arseniate of soda: an agreeable lilac was obtained.

Exp. XI. Common white arsenic dissolved in water, gave a lilac colour somewhat dark.

Though the author intended only to try the action of the metals lately discovered on the colouring matter of cochineal, results before obtained from lead induced him to subject this metal also to some new trials. He undertook at the same time to ascertain how far the use of nitrate of tin is indispensably necessary in dyeing common scarlet, by endeavouring to substitute for that salt muriate of the same metal. These researches gave rise to the following experiments:

Exp. XII. A solution of acetite of lead being poured into tincture of cochineal, a violet blue precipitate was formed. A piece of kerseymere prepared with acetite of lead was then immersed in the same tincture, and a very agreeable violet colour was obtained.

Exp. XIII. A solution of fine English tin in pure muriatic acid was exposed for four weeks in an open vessel to the action of the air. A piece of kerseymere being boiled in this solution, and then immersed in warm tincture of cochineal, it assumed a bright scarlet colour.

This result is the more remarkable, as it has hitherto been believed that it was impossible to dye scarlet without a solution of tin in aqua-regia; and indeed the red obtained by employing common muriate of tin inclines to violet. It appears, therefore, that the oxygen of the nitric acid brightens the colour. As the same state of oxidation may be communicated to muriate of tin by exposure to the air as by nitric acid, the expense occasioned by the use of this acid and that of sal-ammoniac may be spared by substituting muriatic acid, which is much cheaper.

Exp. XIV. A piece of kerseymere was boiled for three minutes in a neutral solution of muriate of barytes, and then immersed in tincture of cochineal. The stuff assumed a dark colour, which, after being washed and dried, changed to an agreeable violet.

Exp. XV. Nitrate of barytes employed as a mordant gave a ponceau red exceedingly agreeable.

Exp. XVI. Acetite of barytes tried for the same purpose, gave

gave a dark red ponceau; which, however, poſſeſſed great brightneſs.

Exp. XVII. A piece of kerſeymere was dipped for three minutes in a ſolution of muriate of ſtrontian, and then immerſed in a bath of cochineal. It aſſumed a dark colour; which at firſt imitated that of ſcarlet, but which by drying paſſed to crimſon.

Exp. XVIII. A neutral ſolution of nitrate of ſtrontian produced a bright reddiſh brown.

Exp. XIX. Acetite of ſtrontian produced a bright *ponceau.*

The reſults of theſe experiments prove, not only that the metals and earths ſubjected to trial poſſeſs a certain chemical affinity for the colouring matter of cochineal, and are capable of fixing it on ſtuffs, but that they poſſeſs alſo the property of producing with the ſame pigment very different ſhades. They prove beſides, that the nature of the acid, which ſerves as a ſolvent to theſe ſubſtances, exerciſes a great influence on the ſhades produced.

The reſults obtained with the oxide of arſenic and the acid of that metal, are no leſs worthy of attention. The difference of the colours produced is particularly remarkable. The oxygen, no doubt, had the greateſt ſhare in this phænomenon, as this principle manifeſts, in a very evident manner, its great influence in the production of ſcarlet by the muriate of tin oxidated by the air.

LII. *On the Manner of Hunting and Sporting by the Engliſh in Bengal. Communicated by Colonel* G. Ironside *.

FEW parties of pleaſure can be more agreeable than thoſe for hunting, formed by ladies and gentlemen in Bengal, particularly at ſome diſtance from the preſidency of Fort William, where the country is pleaſanter, and game of every kind in greater plenty. Any time between the beginning of November and end of February is taken for theſe excurſions; during which ſeaſon the climate is delightfully temperate, the air perfectly ſerene, and the ſky often without a cloud.

To tranſport the tents and other requiſites, for the accom-

* From the *Aſiatic Annual Regiſter for* 1801.

modation of the company, to ſome verdant ſpot, near to a grove and rivulet, previouſly ſelected, elephants and camels are borrowed; ſmall country carts, oxen, and bearers hired, at no conſiderable expenſe, the price of all kinds of grain, and wages of courſe, being exceedingly reaſonable. Nor does the commanding officer of the troops within the diſtrict often refuſe a guard of ſepoys to protect the company from the danger of wild beaſts, (for ſuch generally reſort to the haunts of game,) or the depredations of ſtill wilder banditti, now and then pervading the country.

The larger tents are pitched in a ſquare or circle, while thoſe for the guards and ſervants uſually occupy the outer ſpace. Every marquée for a lady is divided into two or three apartments, for her camp-bed, her cloſet, and her dreſſing-room; is carpeted or matted, and is covered with a ſpreading fly, for defence againſt rain, or excluſion of caſual heat, the air ventilating powerfully between the vacuity (about two feet) of the tent and its canopy in unremitted undulation. The doors or curtains of the marquée, wattled with a ſweet-ſcented graſs, are, if the weather chance to become ſultry, continually ſprinkled with water from the outſide; and a chintz wall, ſtained in handſomely-figured compartments, encompaſſes the whole.

For the ſupply of common food, if no village be very near, petty chandler ſhops enow are engaged by the family banyans (houſe ſtewards) to accompany them, glad to profit of ſuch an opportunity of gain. Liquors and every ſpecies of European articles are provided by the party themſelves.

Horſes are employed for the conveyance of the gentlemen, and palanquins for the ladies, with their female attendants; and, where the roads will admit of it, cloſe and open Engliſh carriages alſo.

Part of the morning ſports of the men, commencing at dawn of day, conſiſt in rouſing and chaſing the wild boar, the wolf, and antelope (or gazelle), the roebuck, the muſk, the red and other deer, hares, foxes, and jackalls: beſides the common red, the ſpotted and the ſmall mooſe, there are ten or twelve ſorts of hog or ſhort-briſtled deer. Boars are uſually found amongſt the uncultivated tracts, or the more regular plantations of ſugar-canes, which give to their fleſh the fineſt flavour imaginable. Wolves and jackalls are ſeen prowling and lurking, at break of day, about the ſkirts of towns and villages, or retiring from thence to their dens within woods; or within pits, hollows, or ravines, on the downs. Hares ſhelter in the ſame ſituations as in England.

The

The hog, roebuck, and muſk deer, conceal themſelves amongſt the thickeſt heath and herbage, and the antelope and large deer rove on the plains. All theſe animals, however, reſort not rarely to the jungles (or very high coarſe and implicated graſs), with which the levels of Hinduſtan abound, either to graze, to browſe, or in purſuit of prey.

A country of Aſia abounding in ſuch variety of game, is, of courſe, not deſtitute of wild beaſts; the principal of which are the tiger, leopard, panther, tiger cats, bear, wolf, jackall, fox, hyæna, and rhinoceros. The leopards are of three or four kinds.

Or the gentlemen divert themſelves with ſhooting the ſame animals; as alſo common partridge, rock partridge, hurriâl or green pigeons, quail, plover, wild cocks and hens, curlews; black, white, and gray peacocks; florikens, ſtorks of ſeveral kinds and colours, together with water hens, Braminy geeſe, cranes, wild geeſe and ducks, teal, widgeons, ſnipes, and other aquatic fowl, in infinite abundance; many of them of extraordinary ſhape, of glowing variegated plumage, and of unknown ſpecies; whoſe numbers almoſt cover the water whilſt they ſwim, and, when alarmed, and fluſhed from the lakes, like a cloud, abſolutely obſcure the light.

The foxes are ſmall, ſlenderly limbed, delicately furred with a ſoft brown hair, and by no means rank in ſmell; feeding principally upon grain, vegetables, and fruit. They are exceedingly fleet and flexible, though not ſtrong or perſevering. When running, they wind in ſucceſſive evolutions to eſcape their purſuers, and afford excellent ſport. Their holes are uſually excavated, not in woods, but on hillocks, upon a ſmooth green ſward or lawn, where, in a morning or evening, they are ſeen playing and friſking about with their young. They feed generally amongſt the corn, and are ofteneſt found within fields of muſtard or linſeed, when it has ſprouted up high enough to conceal them.

A minor critic, on peruſal of Æſop's or rather Pilpay's fables, ridiculed the idea of foxes feeding upon grapes; but, had he conſulted any Aſiatic natural hiſtory, he would have learnt that they ſubſiſt upon grain, pulſe, and fruit, particularly grapes and pine-apples when within their range, much more than upon fleſh or fowl. Or, had he turned to the Bible, he would have there found the following paſſage in confirmation of it:—"Take us the foxes, the little foxes, that ſpoil the vines, for our vines have tender grapes."—*Canticles*, c. ii. ver. 15.

Jackalls are rather larger than Engliſh foxes; but of a

 brown

brown colour, clumfier fhape, and not fo pointed about the nofe. In nature, they partake more of the wolf than of the dog or fox. Their real Afiatic name is fhugaul, perverted by Englifh feamen trading to the Levant (where they are in plenty on the coafts of Syria and Afia Minor) into jackalls.

Of the partridge there are feveral kinds, one with a white belly, and another fomething like groufe, only more motley feathered.

Plover too are various; and, when the weather becomes warm, ortolans traverfe the heaths and commons in immenfe flocks.

There are no pheafants in the woods of Bengal or Bahar nearer than the confines of Affam, Chittagong, and the range of mountains feparating Hinduftan from Tibet and Napaul. But there, particularly about the Morung and in Betiah, they are large and beautiful, more efpecially the golden, the burnifhed, the fpotted, and the azure, as well as the brown Argus pheafant.

As for peacocks, they are every where in multitudes, and of two or three fpecies. One tract in Oriffa is denominated More-bunje, or the Peacock Diftrict.

Cranes are of three forts, and all of a cærulean gray: the very lofty one, with a crimfon head, called *farus*; the fmalleft, called *curcurrah*, (the *demoifelle* of Linnæus and Buffon,) uncommonly beautiful and elegant, whofe fnow-white tuft, behind its fcarlet-glowing eyes, is the appropriate ornament for the turban of the emperor alone; and the middle-fized one with a black head, the common grus. They return to the northern mountains about the autumnal equinox, after ceffation of the periodical rains, with their young, in myriads of flights, frequent as the wood pigeon in North America; and fometimes, when the wind is very violent, flocks of them mount to a vaft height in the air, and there wind about in regular circles, feemingly with much delight, and venting all the time a harfh difcordant fcream, heard at a confiderable diftance.

In the wilds of Hinduftan certainly originated the common domeftic fowl, for there they are difcovered in almoft every foreft. They are all bantams, but without feathers on their legs; the cocks are in colour all alike, what fportfmen call ginger red; they have a fine tufted clufter of white downy feathers upon their rumps, are wonderfully ftately in their gait, and fight like furies. The hens are invariably brown. It is extremely pleafant, in travelling through the woods early in a morning, to hear them crowing, and to perceive the

7 hens

hens and chickens ſkulking and ſcudding between the buſhes. For food, they are neither ſo palatable nor tender as the tame fowl.

Florekins are amongſt the *non deſcripta,* I believe, in ornithology. A drawing can alone exhibit an adequate repreſentation of this fine bird; it harbours in natural paſtures amongſt the long graſs, on the extremity of lakes, and the borders of ſwampy grounds, lying between marſhy ſoils and the uplands. Hence its fleſh ſeems to partake, in colour and reliſh, of the nature and flavour of both the wild duck and the pheaſant; the colour of the fleſh on the breaſt and wing being brown, but on the legs perfectly white, and the whole of the moſt delicate, juicy, and ſavoury flavour conceivable.

There are only three claws to its feet; the roots of the feathers of the female are of a fine pink colour.

When the cock riſes up, ſome fine black velvet feathers, which commonly lie ſmooth upon his head, then ſtand up erect, and form a tuft upon his crown and his neck.

When ſet by dogs, it lies cloſe, and ſcarcely ever riſes till the fowler is ſo near as almoſt to tread upon it. The neſt of it is made amongſt the graſs.

You read of them in deſcriptions of antient knightly feſtivals of the Nevilles, Percys, Mortimers, Beauchamps, Montacutes, De Courceys, Mohuns, Courtenays, and Mowbrays, under the name, I believe, of *flanderkins*; but whether they were then native of England, I am uncertain.

The height of the cock florekin of Bengal, from the ground, when he ſtands, to the top of his back, is ſeventeen inches.

The height from the ground to the top of his head, when he holds it upright, is twenty-ſeven inches.

The length from the tip of his back to the end of his tail, is twenty-ſeven inches.

In no part of ſouthern Aſia did I ever hear of woodcocks; but amongſt the breed of ſnipes there is one called the painted ſnipe, larger than ordinary, and which well compenſates for want of the former.

Fiſhing, both with lines and diverſity of nets, is the employment of other ſets of the party; or the hawking of herons, cranes, ſtorks, and hares, with the falcon; and of partridge and leſſer birds, with the ſparrow and ſmall hawks.

Ladies now and then attend the early field: if it be to view the courſing or hawking, they mount upon ſmall gentleſt (for they are all gentle) female elephants, ſurmounted with arched-canopied and curtained ſeats; otherwiſe they ride on horſeback; more frequently however in palanquins, under which, as well as under the elephants and horſes, the birds, (parti-

cularly the white ſtork or paddy bird,) when pounced at by the hawks, and the little foxes, when hard preſſed by the dogs, often fly for ſhelter and protection. In general, however, the ladies do not riſe betimes, nor ſtir out till the hour of airing.

The weapons in uſe on theſe expeditions are, fowling-pieces, horſe piſtols, light lances or pikes, and heavy ſpears or javelins; and every perſon has, beſides, a ſervant armed with a ſcymitar or ſabre, and a rifle with a bayonet, carrying a two-ounce ball, in the event of meeting with tigers, hyænas, bears, or wild buffaloes. Some of the ladies (like Thaleſtris or Hypolita, quite in the Diana ſtyle,) carry light bows and quivers to amuſe themſelves with the leſſer game.

The dogs are, pointers, ſpaniels, Perſian and European greyhounds, and ſtrong ferocious lurchers. Near Calcutta a few gentlemen keep Engliſh hounds; but their ſcent quickly fades, and they ſoon degenerate.

But the livelieſt ſport is exhibited when all the horſemen, elephants, ſervants, guard, and hired villagers, are aſſembled and arranged in one even row, with ſmall white flags (as being ſeen furtheſt) hoiſted pretty high at certain diſtances, in order to prevent one part of the rank from advancing before the reſt. Proceeding in this manner, in a regular and progreſſive courſe, this line ſweeps the ſurface like a net, and impels before it all the game within its compaſs and extent. When the jungle and coppice chance to open upon a plain, it is a moſt exhilarating ſight to behold the quantity and variety of animals iſſuing at once from their coverts: ſome are driven out reluctantly, others force their way back into the brake. During this ſcene of development, rout, and diſperſion, prodigious havock is made by the fowlers, falconers, and huntſmen, whilſt the country people and children, with ſticks and ſtaves, either catch or demoliſh the fawns, leverets, wild pigs, and other young animals, which have returned into the coppice.

Inſtances occaſionally occur, where the natives of the vicinage petition the gentlemen to deſtroy a tiger that has infeſted the diſtrict, to the annoyance and devaſtation of their flocks and ſhepherds, and perpetual alarm of the poor cottagers themſelves. Although an arduous and perilous adventure, and what the gentlemen all profeſs, in their cooler moments, to reprobate and decline, yet, when in the field, they generally comply with the ſolicitation, and undertake the exploit. Their inſtant animation, not unattended with emotions of benevolence and compaſſion, preſently ſuperſedes every dictate of prudence, and, ſpite of their predetermination, they

proceed

proceed to the affault, the villagers all the while ftanding aloof. If conducted deliberately, with circumfpection, and with the aid of the fepoys, they foon accomplifh their purpofe, and bring in the moft dreadful and formidable of all tremendous beafts, amidft the homage and acclamations of the peafantry. But fhould they lofe their prefence of mind, prolong or precipitate the conflict, act with incaution, or attack the exafperated infuriated favage with tumult and confufion, the event is often fatal, by his feizing, lacerating, and crufhing, every creature within his reach; nor ceafing to rend, tear, claw, and deftroy, to the very moment of his deftruction, or of his flight.

Sometimes do the natives entreat the gentlemen to rid them of wild buffaloes, (the largeft of all known animals, the elephant excepted,) that have laid wafte their cultivation; and at others, to clear their vaft tanks, or fmall neighbouring lakes, of alligators, which devour their fifh, or do mifchief on fhore. So much hazard is not incurred, however, by achievements of this fort, as from the encounter of a tiger; for though the hides of thofe creatures refift a ball from a firelock at common mufket diftance, they are by no means impenetrable to fhot from a rifle, or other pieces with a chamber, or of a wider calibre.

A drum, with a banner difplayed from the hall-tent, gives fignals to the company for their meals.

Breakfaft is a moft delightful repaft: the fportfmen return keen, frefh, ruddy, and voracious: and the appearance of the ladies in fimple loofe attire, the elegant difhabille of cleareft muflin with plain floating ribbons, and difhevelled treffes, captivate to fafcination. Nor is the palate lefs gratified: Englifh, French, Italian, and Dutch viands, all combine to provoke it, by a profufion of cold victuals, falted and dried meats and fifh, hams, tongues, faufages, hung-beef, fallads, chocolate, coffee, tea, frefh milk, preferves, fruit, and eggs, rendered ftill more grateful by the moft fprightly cheerfulnefs and Auroral gaiety.

After breakfaft, conveyances of different forts are prepared for an airing, not merely for the fake of airing only, but to view fome natural or artificial curiofity or manufacture; fome noted town, diftinguifhed mofque, celebrated pagoda, renowned dirgâh, or venerable maufoleum; fome confecrated grove, the fequeftered refidence of fakeers, or fome extenfive profpect from the fummit of rugged cliffs, impending over an expanfe of water, bordering perhaps a level lawn, whofe verdure is vaulted only, not concealed, by a diffufed affemblage of ftately columniated palms of four different fpecies,

tufted and foliaged only, in graceful inclinations at their capitals, all equally ornamental, the date, the cocoa-nut, the beetel, and the palmyra.

Between the airing and an early dinner, the hours are irregularly difpofed, as chance may dictate, or caprice fuggeft. Some play at cricket and quoits, fwim, jump, fence, run a match of horfes, or fhoot at a mark; whilft others direct the mountaineers and woodmen (who rove about in bands for this exprefs purpofe) where to inveigle, entangle, or kill beafts, birds, fifh, and fnakes, for which they are furnifhed with variety of implements, fuch as matchlocks, tiger-bows, fpears, darts in grooves, balls in tubes, pellet-bows, limed rods, ftakes, and bufhes; fafcinating allurements, fuch as painted, fpotted, and foliaged fcreens, bells, nets, and torches, bundles of twigs, rufhes, and reeds, artificial ducks and decoy birds, with traps, gins, fprings, fnares, and other ftratagems and inventions of wonderful enchantment, ingenuity, mechanifm, and contrivance.

It is fomewhat extraordinary, but neverthelefs a fact, the influence of fafcination poffeffed by the tiger, and all of his, (the feline) fpecies, over many other creatures. 'Spied by deer particularly, they ftop at once, as if ftruck by a fpell, while the tiger lies ftill, his eyes fixed on them, and quietly awaiting their approach, which they feldom fail to make gradually within his fpring; for the large royal tiger cannot run fpeedily or far. The glow of their eyes is fierce and powerful. I myfelf once paffed a royal tiger in the night near a wood, and could plainly perceive the fcintillations from his eyes. He was deterred from approaching us by the light of flambeaux, and the noife of a fmall drum which we carried, and was beat by a fervant for the purpofe of fcaring him away.

Wherever tigers roam or couch, a number of birds continually collect or hover about them, fcreaming and crying as if to create an alarm. But the peacock feems to be particularly allured by him; for the inftant a flock of pea-fowl perceive him, they advance towards him directly, and begin ftrutting round him with wings fluttering, quivering feathers, and briftling and expanded tails. Of this enticement the fowlers alfo make their advantage; for, by painting a brown cloth fcreen, about fix feet fquare, with black fpots or ftreaks, and advancing under its cover fronting the fun, the birds either approach towards them, or fuffer them to fteal near enough to be fure of their mark, by a hole left in the canvas for them to fire through.

Several other inftances of the fafcination of animals I have myfelf been witnefs to in Bengal. Three or four times, where a line

a line of troops were marching in a long uninterrupted ſeries, paſſed a herd of deer; I obſerved that when their attention was taken off from grazing, by the humming murmuring noiſe proceeding from the troops in paſſing, they at firſt and for a while ſtood ſtaring and aghaſt, as if attracted by the ſucceſſive progreſſion of the files, all clothed in red. At length, however, the leading ſtag, "*vir gregis ipſe*," ſtriking the ground, ſnorted, and immediately ruſhed forward acroſs the ranks, followed by the whole collection, to the utter diſmay and confuſion of the ſoldiery: thus running into the very danger one naturally ſuppoſes they muſt have at firſt been anxious to avoid. The men, who were appriſed by the ſound of their approach, ſtopped, and made way for them. Over the heads of the others, who were heedleſs and inattentive, they bounded with wonderful agility, and fled over the plain.

Driving one evening along the road in a phaëton, and pretty faſt, I perceived a young heifer running near the carriage, with her eyes intently fixed upon one of the hind wheels; by the whirling of which the animal ſeemed completely ſtruck and affected. Thus purſuing her object for about a quarter of a mile, ſhe, by a ſudden impulſe, rapidly darted forward towards the wheel, which then ſtriking her noſe, the attention of the creature became interrupted by the violence of the friction, and was, of courſe, withdrawn: ſhe then immediately ſtood ſtock ſtill, and preſently after turned about ſlowly and made off.

Beyond all other animals, however, ſerpents poſſeſs moſt eminently this occult power: frequently are they ſeen revolved on the branches of trees, or on the ground, meditating their prey, either birds, ſquirrels, rats, mice, bats, frogs, hares, or other animals.

The ladies, as they are inclined, either read, walk, ſwing, exerciſe themſelves in archery, or at ſhuttlecock in the groves; or they ſing and play in their tents. Others, whilſt at work, are read to by their companions; of all amuſements, perhaps, the moſt delectable.

At the end of a convivial dinner, every ſoul, provided the weather prove ſultry, or they find themſelves fatigued, retires to repoſe.

On riſing from this ſieſta, (of all liſtleſs indulgences the moſt ſoothing, comfortable, and refreſhing, and certainly moſt wholeſome, all animals inclining to ſleep after nouriſhment,) carriages are again in readineſs, or light boats where a ſtream or lake is near, to give the company the evening's reſpiration,

(which the inhabitants of colder regions taste only in poetical description,) breathing health as well as recreation.

The twilight being short under the tropics, the day, of course, shuts in presently after sun-set, when cards and dice become part of the evening's entertainment. Chess, back-gammon, whist, picquet, tredrille, quinze, and loo, are the favourite games. These, with domestic sports, antics, gambols, tricks, pranks, and frolics, where the humour prevails; together with the slights of jugglers, feats of tumblers, (in which performances the Hindus are expert adepts,) and dances of the natives, wile away the time, and beguile it not unpleasantly to the hour of supper, the principal meal; when a repast, enlivened by every elevation of spirit and kindly disposition that can conduce to promote good humour and festive hilarity, terminates the day.

These parties generally continue, with some variation in the amusements, fifteen or twenty days; and the dissolution of them is as generally lamented, with heart-felt regret, by the individuals who compose them.

LIII. *Observations upon the Monsoons, as far as they regard the Commerce and Navigation of the Port of Bombay* *.

OUR readers will not require to be told that our year is divided into two grand seasons, or, as they are called, the south-west and north-east monsoon; that the first generally prevails from May to the middle of September inclusive, the other during the remaining months; yet we must premise this as an introduction of what follows.

We need scarcely to observe, that during the south-west monsoon all the ports and roadsteads on this side of India deny approach; so much so, that between the 15th of May and the 1st of September ships are precluded by their policies from touching upon the Malabar coast, or from lying in Surat roads between the 1st of May and the 1st of September. Generally speaking, the monsoon is considered to extend from Dunder-head, the southern extremity of Ceylon, to the Persian Gulf; in order to attain which, they who should sail at this season would be obliged to make what is called a southern passage, that is, go first to the south of the equator before they could stretch over to the westward; a voyage that would occupy, for Muscat about forty days, and

* From the *Asiatic Annual Register for* 1802.

to

to Buſſorah about two months. The ſame objection exiſts againſt ſailing at this ſeaſon to any part of the Arabian coaſt. As for the Red Sea, it is conſidered in vain to attempt entering it at this ſeaſon; nor can it be ſaid to be favourable to ſail now to the Cape, the Mauritius, or any port to the weſtward.

To the other ſide of India, on the contrary, it is now the moſt advantageous period of departing. From the middle of April, even to the middle of Auguſt, a voyage to Madras may be made in about 12 or 15 days; to Bengal from 15 to 20 days: after this time it becomes exceſſively tedious, from the neceſſity of keeping to the eaſtern ſide of the bay, to avoid the violent weather on the Coromandel coaſt. For the ſame reaſon the ſouth-weſt monſoon is eligible to leave Bombay for any of the ports in the Gulf of Bengal or the Streights of Malacca; hence alſo it is the ſeaſon for ſailing to China: after the 20th of Auguſt, however, what is called the direct paſſage to China becomes very precarious, with much probability of finding blowing weather in the Chineſe ſeas.

With regard to the ports from which ſhips may be expected to arrive at Bombay during this monſoon, it may be laid down as a general rule, that the quarters favourable to ſail to during any ſeaſon, are thoſe that it is unfavourable to expect arrivals from, and *vice verſa:* hence from the Perſian Gulf, the Red Sea, the Cape of Good Hope, and the weſtward in general, this is the moſt ſeaſonable period to expect arrivals: from Muſcat a trip may now be made in 10 or 12 days, from Mocha in 20 days, and Suez in about a month. It ſhould be remarked, that after September the Red Sea admits of no egreſs; ſhips conſequently remaining there beyond that time, muſt continue there all the north-eaſt monſoon, and are ſaid to have loſt their paſſage: on this account, the 25th of Auguſt is the lateſt day to which our cruiſers are allowed to remain at Suez. From the Cape a paſſage may be made in five or ſix weeks; from the Mauritius, in three weeks or a month.

The ſouth-weſt monſoon is alſo the moſt favourable ſeaſon in which a paſſage may be made from Batavia or any ports to the eaſtward through theſe ſouthern ſtreights: from Batavia to Bombay, in particular, a paſſage may be made in about 35 days. From Madras and Bengal, during the ſouth-weſt monſoon, it is neceſſary to make the ſouthern paſſage in order to reach Bombay: this will require, in a paſſage from Madras, from 30 to 40 days, and from Bengal from 45 to 60 days, from the neceſſity of working out of the river, and beating down the bay to clear Acheen Head. From the

Streights

Streights of Malacca it is an arduous taſk to ſail for this port, or even to any one on the peninſula of India, owing to the difficulty of working round Acheen Head.

We have now to treat of the north-eaſt monſoon, or the ſeaſon which may be conſidered as included between the 15th of Auguſt and the 15th of April; in which the firſt circumſtance that occurs to us to remark is, that our coaſt is rendered in a peculiar manner ſecure and favourable to navigation; it is now conſidered the moſt eligible period for ſailing to the Perſian Gulf, and in general to all ports to the weſtward. To Muſcat the trip is generally 15, and to Buſſorah 28 days. The time ſuitable for ſailing to Mocha and Suez is from the middle of February to the middle of March, when a paſſage may be made to the firſt in 18 days, to the ſecond in 25. If a ſhip be delayed till the latter end of March or the beginning of April, the paſſage becomes more tedious, being then obliged to make the land to the ſouthward of the iſland of Socatra before the gulf can be entered, on account of the ſoutherly winds which prevail, and a current ſetting to the northward. After the 15th of April, a ſhip bound to the Red Sea would be very likely to loſe her paſſage.

Between the 15th of Auguſt and the 15th of September it may be conſidered favourable to ſail to Madras and Bengal; but after this time the ſeaſon is ſuſpended, owing to the ſetting in of the north-eaſt monſoon on the other ſide of India, which cloſes the ports on the coaſt of Coromandel, Golconda, and Oriſſa, between the 15th of October and the 15th of December; at leaſt this period is excepted in common policies of inſurance. After this time, again, a paſſage may be made to Madras in 30, and Bengal in 50 days. This ſeaſon may be deemed unfavourable to the coaſt of Pegue and the Streights of Malacca; but for the Streights of Sunda, Batavia for example, it is the beſt adapted—a paſſage thither may be made in 35 days.

With regard to the ſeaſonable imports in this monſoon, it is at no time more advantageous than now for coming from the Coromandel coaſt, and, in ſhort, the whole bay: a paſſage may be made from Madras in 20 days, from Bengal in a month, and Penang a month. From the Perſian Gulf it is no leſs favourable, the paſſage from Muſcat being about ten days; and from Buſſorah 28. The Red Sea is now cloſed; nor is it reaſonable to expect arrivals from the Cape or the Streights of Sunda; from the latter, in particular, it is almoſt impoſſible at this ſeaſon to make a tolerable paſſage.

LIV. *Me-*

LIV. *Method of obtaining inodorous Benzoic Acid.* By M. F. Giese *.

THE benzoic acid, ſuch as we obtain it in the dry or humid way, always retains a peculiar ſtrong agreeable odour, which has hitherto been conſidered as a particular character of this acid. The numerous experiments I have made on this acid ſhow that chemiſts in this reſpect have been in an error, and that the benzoic acid may be deprived of all its odour without injuring its principles or altering its nature.

I was led to this obſervation by remarking, that the ſame acid extracted from the urine of graminovorous animals, when deprived of all urinous odour, is perfectly inodorous. This circumſtance induced me to believe that the odour of the benzoic acid might be foreign to it; and to aſcertain this fact I made the following experiments:

I united odorous benzoic acid to a ſolution of potaſh, and then precipitated by muriatic acid. On each repetition of the experiment the odour was ſenſibly diminiſhed, and after the third it had totally diſappeared.

As the acid retained all its characters, this ſeems to prove that in theſe operations it had experienced no particular modification †. This reſult was previouſly indicated by its acquiring, in the progreſs of the experiment, the odour of benzoic acid obtained in the humid way, which is much weaker than that of the ſame acid obtained by ſublimation.

I afterwards invented another method, more direct and leſs troubleſome, for depriving this acid of its odour. It is founded on the greater ſolubility of the benzoic acid in ſpirit of wine than in water; and on the ſolubility of the benzoic oil, which is the principle of its odour, in diluted ſpirit of wine. This method is as follows:

Diſſolve benzoic acid in as ſmall a quantity as poſſible of ſpirit of wine: filter the ſolution, and drop water into it until no more precipitate is formed, or until the precipitate formed begins to be rediſſolved. Separate the liquor by filtration, and dry the acid, which remains on the filter, at a gentle heat.

* From Scherer's *Allgemeines Journal der Chimie*, February and March 1802.

† I can certify that a ſpecimen of this acid, ſhown to me by the author, was abſolutely free from odour. I requeſted M. Gieſe to ſubject the inodorous acid to ſublimation, in order to aſcertain whether a decompoſition experienced by the heat was not the cauſe of its odour. He complied with my requeſt; but he obſerved no alteration in the acid, nor had it reſumed its odour.—Scherer.

I ſhall

I ſhall here add, that having ſaturated the benzoic acid with lime, and decompoſed the benzoate thence reſulting by the muriatic acid, I obtained an acid without odour; and that M. Richter obtained the ſame inodorous acid by decompoſing the benzoate of potaſh by acetite of lead, and then the benzoate of that metal by the ſulphuric acid: but of all theſe methods that by ſpirit of wine is to be preferred.

LV. *On the Mammoth.* *By Governor* Pownall.

To Mr. Tilloch.

SIR,

I READ, at Bath, the account which the Philoſophical Magazine, publiſhed by you, gave the public of the mammoth. In my way from Bath to this place, I continued a few days in London: I went twice to ſee the ſkeleton of this enormous animal: the firſt time to take a general view of it; and ſome days after, when I had fully reaſoned in my recollection on the general conſtruction of it, I went a ſecond time to examine it in detail, as far as my ſuperficial knowledge in comparative anatomy would enable me.

I ſhall not in this letter go over all the parts to which I gave my attention, but notice only thoſe parts on which ſome doubts remained with thoſe who had not ſeen it, and which, rightly underſtood, lead to ſome probable conjectures as to the mode and time of its exiſtence in life. I am, Sir,

Your moſt obedient humble ſervant,

J. Pownall.

Everton Houſe,
Jan. 1, 1803.

DOUBTS were made as to ribs being ſet edgeways, ſo different from all other animals of our earth; yet ſuch is the fact, as appears not only from the inſertion of their heads, but from their curvature; alſo from their ſides, wherein is the groove into which the cartilages, by which they are connected, were inſerted. Theſe ribs appear to be of the ſame form and to be in the ſame poſition as the ribs of fiſhes, and ſo deſigned for the ſame purpoſe, to reſiſt an external compreſſure of more weight and force than the preſſure of the atmoſphere.

The printed deſcription left it totally undecided whether this animal had hoofs or toes. On examining the ſetting on of the foot, it appears that it hath the eight uſual bones, in two rows, four in each row, in the carpus, which all animals having digits or toes have: and it hath five toes, whereon, as

as appears from the form of the end-bones, it had nails, not claws.

The pofition given to the tufks feemed doubtful; but, on a view of the fact, it is decifive that they could not have been placed otherwife. They are of a fpiral curvature of one quarter turn: they are fo inferted into the head as to go back alongfide the fhoulders, but at fuch a diftance, as, by the turn of the head with fome curvature of the body, to reach the fides and hinder parts, and from their conftruction and pofition point out evidently, at leaft to me, that they were weapons of defence againft fuch of its enemies as might attack it in the flank or rear, and of deftructive offence alfo in fuch cafe. Of this more hereafter.

The neck is fo fhort that the animal could not reach the ground with its mouth: the line from the withers to the end of the under-jaw is about one-third of the line from the withers to the ground. I did not take an actual meafure of this, but I will venture to affert it from my habit in drawing.

This animal, if a grazing animal, might indeed, as the moofe deer do, feed on young fhoots of the woods, or the bark; or, by going into moraffes up to the breaft in water, feed on the long graffes and water-plants which grow therein: but it is decidedly a carnivorous animal. The woods of the earth in which this animal could live, move, and fuftain its being, muft have been totally different from fuch as at prefent cover the face of the earth; otherwife his enormous form, with the pofition of his tufks, muft have rendered him incapable of penetrating or paffing through them.

Now here let the ingenuity and wit of our philofophers moft renowned as naturalifts fearch into the fact, and tell us what fort of animals could have been his prey, and where fuch could exift in fufficient abundance to fuftain this enormous animal; and if any fuch ever did exift, which we now know nothing of, how he could, be his capacity for velocity fuppofed to be what it may, how he could hunt them in woods into which he could not penetrate, and through which he could not pafs.

The queftion then arifes and remains in doubt, Where muft we look for his habitation and his food? Not being able to find either in the prefent ftate of the earth, my refearch is led to feek it under fome other ftate of this planet. In fearching for fuch ftate of things, I go to the firft information we can obtain of the *hiftory of this fact*, in the divine book of Genefis, written under infpiration: and there I am taught that the original ftate of this planet, *in the firft period* of its exiftence, was that of an aqueous planet. The waters,

over

over the face of which the Spirit of God moved, covered the whole furface of the globe, and had remained in that ftate for two uncertain periods, until the working of nature under the command of God forced up and elevated the earth in parts, fo that the waters were gathered together, which took place in a *third period* of the progreffive exiftence of this our planet.

But apart all authority, any true philofopher, who meets by tracing back the operations of nature in her progreffive advance to the prefent ftate of the planet, will find it in its firft period an aqueous planet; will find that light or caloric, or whatever that firft power was, fpecially gave courfe to other powers; and that the powers of evaporation, both expanfive and attractive, were and are the caufes of the feparation of the elaftic fluid, the atmofphere; that the earth has been thrown up from the bottom of thefe waters by various explofions and volcanic eruptions: and that the earth became, under thefe proceffes, in its vegetative ftate, a fit habitation, firft, for the fowls of the air and all flying infects; and next for the beafts of the field and all creeping things; and laftly, for man, exactly according to the philofophic defcription given in the divine narrative. But while he confiders this advancing progreffion, he will find nothing to decide as to the length and continuance of each of thefe periods. That thefe periods are not to be underftood as *days*, is part of the fact. Becaufe three of thefe periods were paft, according to the narrative itfelf, before that divifion of time took place, which was not till the fourth period.

I fhall now, grounding myfelf on the fact as above ftated, affume that this planet was, in its firft period of exiftence, an *aqueous planet*; and finding nothing to decide or determine the continuance of this period, affume alfo that it continued, according to the courfe of nature in her progreffion, in this ftate for an indefinite period; and further, that in this period and in this ftate of the planet "God created great whales and every living creature which moveth, which the *waters brought forth abundantly* after their kind." I find it difficult to conceive that thefe waters, which are defcriptively faid thus to *bring forth fo abundantly*, fhould remain for four periods of the planet's exiftence totally unproductive till the fifth. The only way that I find to reconcile this difficulty in the divine narrative, is, that thefe marine beings are omitted to be noticed until they are claffed with all other living terreftrial creatures under one head, according to the order of method, not the order of time, in the fifth period, when the earth became a proper *habitation* for fuch terref-

trial

trial creatures. Whether the general denomination of *great whales*, fo peculiarly expreffed here, extended to the leviathan, the behemoth, and other fpecies of great animals, I am not critic enough to judge: but that there were feveral other great animals in thefe waters is a fact.

On this ground I am difpofed to think that, if any remains of any great animals are found amid the wreck which the parts of this planet have fuffered in the revolutions of its nature, whofe fpecies are not now to be found in living exiftence, and to whom the prefent ftate of the earth could neither give an *habitation* or food, even a cautious naturalift may, on theory founded in a combination of circumftances, fairly fuppofe that thofe great animals had their exiftence under the circumftances of the firft period of this planet as an aqueous one, and were deftroyed by the revolution which converted it into a terreftrial one; and that even thofe who were not deftroyed in that cataftrophe muft have become annihilated, as the prefent ftate of the earth is not fuited to their exiftence.

The fkeletons of this fpecies of animal, which is by a Ruffian word denominated mamouth or mamoud, as being enormous like the elephant, and which might juft as properly have had the name leviathan, or behemoth, given to it, are found in different and diftant parts of the world, and under different climates, as on the banks of the Ohio, in the dominions of the ftate of New York, and on the banks of the Obie in Siberia. This circumftance again points out that thefe animals muft have inhabited fome element wherein the climates did not vary to the degree in which they now do on the earth, and whereby there was a general free communication from one fide of the globe to the other, which doth not now take place. Moreover, as the earth is now conftituted, and as the animals thereon exift, the indigenous animals of Europe and of America, howfoever fimilar in their external apparent claffes, are variations in the one country from what they are in the other.

Befides the fkeletons of thefe animals called mammoth, there have been found in other regions of the earth parts of other fkeletons of enormous animals. The fkeleton of one fuch, which is now in Spain, was found in South America. This, from the drawing made of it, appears to differ from the mammoth: but, having been accuftomed to doubt the vaguenefs of draughts, I can fuppofe that this may, on examination, be found to be of the fame nature *.

There

* We have reafon to believe, from a correct drawing, and fome particulars which have reached us of the animal here alluded to, that it is of a different

There are alſo found, in different regions in the earth, the exuviæ and remains of animals of a ſcale in magnitude much beyond thoſe it affords in its preſent ſtate, about which it ſeems almoſt impoſſible to fix any line of conjecture. They are found in all ſtrata, the marine ones chiefly in calcareous ſtrata: this ſkeleton lay in a calcareous ſtratum.

The ſuppoſition that this animal was a marine one, and dwelt in the ocean, relieves the account of it from all difficulties as to its habitation and food. What the woods of the preſent earth deny, the ocean gives full and free courſe to—all its enormous animal capacities of motion. The *abundant ſupply* of the ocean could give food for this carnivorous animal, and food which came within its power to attain, on the banks of flat fiſh, and in the beds of ſhell fiſh. This removes all difficulty as to its ſuſtenance. That the ocean did bring forth ſuch food in ſuch abundance, the phænomena of the marine animal compoſition of the ſtrata of the preſent ſtate of the earth evinces.

That this animal was carnivorous appears to be a decided fact; it might therefore live in an element where was no grazing food: from its enormous bulk it would require a ſupply of animal food which the earth could not give, and which could only be found in the abundance which the waters bring forth.

There are parts in the *debris* of the ſkull which have ſome comparative reſemblance to the whale, as to the purpoſe of breathing under water; and from the width of the jaws, ſomewhat ſimilar to that of fiſh, one may imagine, when imagination is ſet to work, that this animal might have had in thoſe parts ſome glands calculated to carry on the ſame operation as the gills of fiſh perform. The ribs, as obſerved above, more ſimilar to thoſe of fiſh than to thoſe of terreſtrial animals, are by their conſtruction and poſition ordained to reſiſt a much heavier and more forcible external compreſſure than the atmoſphere creates.

I ſhall make no apology for any part of this *theory*, becauſe, being declared to be theory, every one is at liberty to approve or diſapprove the whole or any part thereof; yet I cannot but think that ſome very ſober analytic philoſophers may repoſe their imaginations if not their conviction upon it, until the preſent or ſome future ſyſtem of philoſophy ſupplies them with a better. I will therefore venture to ſay to any philoſophical ſociety, royal or liberal,

——— Si quid noviſti rectius iſtis;
Candidus imperti: ſi non, his utere mecum.

different ſpecies from the mammoth. We ſhall here mention only one ſpecific difference—its ribs are nearly cylindrical.—Edit.

I will

I will not close my reflections on this subject, which was found in North America, and is now exhibited in London by Mr. Peale, a young American, by whose persevering industry it was dug up, without saying in very truth, and not in compliment, that this exhibition will derive every advantage which can arise from an object of this sort, from the modest scientific knowledge and the preciseness of information which this young man, in the true analytic way of an American, explains it; and from the collection of other articles with which he accompanies such explanation as with a commentary.

LVI. *Remarks on the present State of Aërostation.* By *Mr.* G. J. Wright*.

SUBSEQUENT to the discovery of marine navigation, the daily proofs of aërial flight, as witnessed among the feathered tribe, served to suggest to the antients the probability of piercing the unexplored regions of the atmosphere: various have been their attempts for this purpose, which (agreeably to the then pre-eminence of mechanical over the other branches of philosophy) were confined to the invention of machines to assist man himself in imitating the motions of the feathered race, but more particularly to the contrivance of flying automata, as may be learnt from the writings of many authors.

To enumerate and particularize these inventions would be of no avail, especially as the bare recital of many of them would at once confirm their absurdity; so that we may reckon nothing to have been practically concerted toward aërostation till the experiment of one Gusman, a Portuguese friar, who is reported, early in the 18th century, to have launched a paper bag into the air; which however soon fell, after attaining the height of 200 feet.

Many doubts have arisen respecting the truth of this statement, principally from the supposed unacquaintance of the philosophers of that early period with the qualities and varying densities of aërial fluids, as also the little probability that an elastic fluid could be confined, for any length of time, by paper, of which it has been asserted that the pores are indeed impermeable to air, though water easily percolates them: hence it has been inferred that the particles of water are finer than those of air. 'Tis certainly true that air may be confined by paper, provided such air be destitute of moisture, and

* Communicated by the Author.

 incapable

incapable of exerting a chemical action thereon: but if water passes the pores of paper, it is most probably occasioned by its first effecting a solution of the mucilage, by which means the rest of the fluid finds an easy passage; for, the hotter the water, the quicker does it percolate; and this is not attributable to any supposed attenuation of the individual particles of the fluid, but to an actual solution of the paper itself; otherwise the strength of each single fibre would remain unimpaired by the difference of temperature in the water; the contrary to which the manufacture of paper itself will evince.

The difficulty, therefore, of obtaining the gases in a state of dryness in so large a quantity as is required for aërostatic experiments, will ever remain an impediment to the use of paper for any other than balloons of small diameter, and on the principle of Montgolfier. Two brothers of this name, natives of France, considering the difference in the specific gravity of heated and cool air, justly imagined, that if a bag, sufficiently large, were filled with the former, the weight of the inclosed heated air and bag together would be less than an equal bulk of atmospheric air of ordinary temperature, and that such an apparatus would ascend till it should attain that elevation where the respective gravities would correspond.

Experiment fully verified the opinion they had formed, and M. Pilatre de Rozier was the first to make trial of its security.

The inconveniences peculiar to machines rendered buoyant by heated air, arose from the impossibility of keeping up the elevated temperature of the inclosed air without the continued renewal of fuel, and that in large quantity; whereby the travellers were exposed to great danger from the occasionally sudden and unavoidable expansion of the flames, and their inability to command that uniformity of rarefaction so necessary to the safety of the voyage.

As aërial chemistry had been before this time making rapid advances, so the philosophical world, through the indefatigable labours of the honourable Mr. Cavendish, had been made acquainted with the properties of inflammable air, whose specific gravity, in a tolerably pure state, is at least twelve times lighter than atmospheric air. Doctor Black first applied this newly discovered gas to balloons, by suggesting its inclosure in an air-tight bag, as capable of raising itself into the atmosphere, agreeably to the common hydrostatical axiom, that bodies immersed in a fluid heavier than themselves must inevitably float in that fluid; and that, as the density of fluids is proportionate to their heights, so the lighter body will continue to rise till its gravity shall corre-

spond

spond with that of an equal bulk of the fluid in which it is immersed. Although Dr. Black undoubtedly first suggested the propriety of applying inflammable air to aërostatic purposes, Mr. Cavallo had the honour of first putting it into practice, which we find him to have been engaged in performing in the year 1782: but his experiments went no further than a demonstration of the doctor's suggestions; and the ascent of soap-balls filled with inflammable air (as being the first experiment of the kind) is an original idea, for which we are indebted to him.

The first inflammable-air-balloon was launched on the continent by Messrs. Roberts and a Mr. Charles in the year 1783; and the greater expediency of these latter machines over those elevated by heated air, soon raised them to that pre-eminence they seemed justly entitled to: yet even with these there was conjoined the disadvantage of not being able to raise or lower them without a loss of ballast in the first, and of gas in the latter case. This suggested the idea of inclosing a bag of heated air in one of inflammable air, whereby, on varying the temperature of this inner balloon, the whole apparatus could be raised or lowered *ad libitum*, without loss of gas or ballast. But as the vicinity of fire to hydrogen air and common air endangers a mutual explosion, so this unfortunate plan deprived the world of that most intrepid philosopher M. Pilatre de Rozier, who has the honour to bear the palm of aërostation, in being the first man who ever abandoned himself to the atmosphere in a balloon.

If we consider the natural disposition of Frenchmen, ever prompting them to the pursuit of novelty, we shall not be surprised to find them warm advocates for the progress of this new art; eccentricity in the choice of their researches and amusements having been ever a prominent trait in their national character. Enlivened by the native softness of their climate, their dispositions partake of that gaiety which is to be found only in a country like theirs, where a less sluggish atmosphere and more uniform temperature tend to preserve a constant vivacity of mind. A latitude so favoured with serenity of season produces an abundance of vegetables and fruits, the want of a greater mixture of which in the diet of Englishmen causes the more prevalent sedateness of their manners, subdues a tendency to volatility, and keeps them from wandering from one pursuit to another. Hence we are less likely to witness among ourselves that sudden enthusiasm for the progress of any new art, and especially of this (to some) seemingly unimportant one: we have therefore had very few instances here of balloon excursions undertaken by

really philosophical men; and, except Mr. Baldwin, none have contributed aught to the science. His treatise *, compiled from the memoranda of a single voyage, is without its equal, and under such a philosopher the art must soon have attained all the perfection it could be capable of; while its present low state can be attributed only to the impossibility of finding his rival. The treatise of Mr. Cavallo † is an excellent book for practical purposes; and in these two volumes we find all the yet ascertained facts relating to aërostation ‡; the pamphlets compiled by others being of no value, as containing for the most part a repetition merely of trifling occurrences of no avail to future balloonists.

Subsequent to the experiment of Messrs. Charles and Roberts, many voyages were undertaken, both in France and this country, during the years 1784 and 1785: and after the public curiosity was in some measure abated, the pursuit itself sunk in the general opinion, and received attention only from a Mr. Blanchard, a French gentleman, who for years before had been devising various methods to fly by mechanical means. This amateur (who has made near fifty aërial voyages, and who, in his several attempts to improve the art, has met with some unfortunate accidents) is the original inventor of the parachute; but his essay therewith was not attended with success to himself §, although the animals he at times had committed to it for descent never experienced the slightest shock. Excepting then Mr. Blanchard, we find the art making no further progress; and even the attempts of this gentleman for the purpose proved abortive.

The second æra of aërostation may be said to commence with the establishment of the aërostatic school at Meudon, in the vicinity of Paris ||; and the first immediate service of a balloon appears to have been derived in the battle of Fleurus, in the Austrian Netherlands, where from an elevated station the French aëronaut beheld the movements of the enemy; and by indicating the same by a telegraph purposely attached to the car, the battle is reported to have been gained by the French, principally from this contrivance to overlook the operations

* Aëropaidia, or Narrative of a Balloon Excursion from Chester; by T. Baldwin, A. M. 1786.

† History and Practice of Aërostation; by Tiberius Cavallo, F. R. S. London 1785.

‡ In the French language we have *Déscription des Expériences Aërostatiques, par M. Faujas St. Fond.* 2 tom.

§ In an experiment at Bâle, in venturing to descend by his parachute, he unfortunately broke his leg.

|| See the account of the French aërostatic institute in the sixth volume of the Monthly Magazine.

rations of the combined armies. Various reports have at times reached us concerning the pretended flourishing state of this aërostatic school; but during the few years of its establishment no improvements appear to have been made further than the composition of the varnish, which is brought to the greatest perfection; and Mr. Garnerin informed me the establishment itself is now given up.

We find then that the apparatus itself has undergone no confirmed improvement; perhaps from the pursuit being generally attended to by enthusiasts in novelty, strangers to genuine science natural or mechanical. Thus an aëronaut in the present day is compelled to go in the direction of the wind; and in descending, calmly sits in his car to be knocked against every tree, house, or hedge, that may come in his way. So long, therefore, as aërial adventurers are liable to such dangerous dilemmas, it is no wonder we find so few inclined to repeat their voyages; as the transitory enjoyment of a view above the clouds, is seldom sufficient to incite a second attempt under such threatening circumstances.

The restoration of peace affording to foreigners an opportunity of visiting this country, whether prompted by curiosity or to exhibit the productions of their inventive genius, this crisis proved a means of again exciting the attention of the English public to the almost forgotten subject of aërostation, as revived by the advertisements of Mr. Garnerin; a man of an ingenious turn of mind, without that collateral acquaintance with the several sciences on which rests the only sure foundation for improving the arts, and especially this peculiar branch of philosophy, which seems to be his native *forte*. Having made a number of aërial voyages, his mechanical acquaintance with the requisites for insuring success was confirmed by frequent experience; but further than this we do not find him to have attained. He is also the first aëronaut that has succeeded in a safe descent by the parachute—an experiment which is of the first consequence to the progress of aërostation. The late voyages made in this country by this latter gentleman are fresh in the memory of every one, and we have only to regret that so experienced an adventurer should possess so small a share of the knowledge requisite to raise aërial navigation to the perfection it might perhaps otherwise soon attain.

As an advocate for ascertaining the issue of whatever may be dubious in the present state of our knowledge, I felt anxious to seize so happy an opportunity of investigating what degree of diminished pressure the human constitution could support, as presented in the intended experiment with the parachute;

rachute: for this reason I offered to Mr. Garnerin, that, as his balloon was capable of carrying four persons, it would be fully adequate to the conveyance of two, together with the parachute and ballast: under such circumstances it would be necessary to suspend the parachute beneath the car; and my intention was to occupy the latter myself. An offer so advantageous for securing Mr. Garnerin's machine (otherwise left at random) was rejected by him, from the acknowledgement of his doubts respecting the event of so novel an experiment. But I trust this experiment will not long remain unattended to by such as may have an opportunity of performing it: the effects subsequently taking place from the loss of a weight of upwards of 200 pounds at an elevation of 10,000 feet, are not so terrific as might be imagined; as during this after-ascent no danger could attach to the machine; for, its neck being open, and thereby affording an exit to the gas, now somewhat more expanded by the absence of the mechanical pressure of the 200 pounds just lost, yet gradually still more expanding itself as it attains in this ascension a zone of air of lesser density, would necessarily prevent any rupture from that cause; while, if the aëronaut found his respiration too much affected to allow his attainment of the utmost height surmountable under these circumstances, he could have nothing to fear so long as he has the valve at command. Neither have we any cause for apprehension from the velocity likely to take place, if the traveller is not too near to the body of the balloon, or in a fitting position; in both which cases it is doubtful whether the approximation to a vacuum * in the *wake* and immediately in the vicinity of the lower pole of a large spherical body, ascending with great velocity, might not endanger *asphyxia*, from the suddenly diminished density of the air received into the lungs †.

At the same time, to such as descend by a parachute from a balloon left at random, I would advise an attention to the following simple precaution, which cannot fail of insuring the

* Agreeably to what we learn in projectiles, that a body moving with a velocity of 1200 feet in a second, leaves behind it an actual vacuum; also exemplified in the common exercise of swinging, where a slightly suffocating sensation is experienced in the retrograde motion of the machine, occasioned by the person sitting in the wake formed by the recoil of his own body.

† As I have no intention to speak in this place of the effects likely to ensue to an aëronaut in cases where, the valve being unexpectedly found out of repair, he is obliged to remain at the then unavoidable equilibrium, I shall reserve these points of discussion as the subject of a paper I propose to transmit at a future opportunity, in immediate reference to the probable effects of diminished atmospheric pressure on the animal system.

speedy

ſpeedy deſcent and recovery of the latter. In aſcending with a parachute according to the preſent conſtruction (the aëronaut being out of the reach of the neck of the balloon), it will be adviſable to leave the neck open about a foot or more: previous to the aſcent procure a cord whoſe length muſt equal half the perpendicular circumference of the balloon when at its full diſtenſion; attach one end of the cord to the zenith of the balloon externally, or to the netting immediately over it, and (leaving it detached throughout the whole of its remaining length) to the other end faſten a weight of about 20 pounds. I ſay, when the ſeparation between the parachute and balloon is made, the latter, being deſtitute of any other poiſe, will gradually yield to this above-mentioned weight, and by its means the open neck of the balloon will progreſſively be made to aſcend; while the zenith will be drawn downwards, the machine thereby inverted, and the preſſure of the external atmoſpheric air will in a ſhort time force out the inflammable gas, and the whole bag quickly deſcend *.

It would appear, from the above ſhort review of the ſtate of aëroſtation, that we have as yet made no further progreſs than the attainment of the means of riſing into the atmoſphere, of aſcending and deſcending a very limited number of times, and of departing from the machine in ſafety in caſe of any immediate wiſh on the part of the traveller when his ſtay therewith appears hazardous. As theſe are matters ſufficient to diſpel apprehenſion from the minds of thoſe who may be inclined to attend to this branch of philoſophy, it may not be amiſs to ſubjoin thoſe requiſites and precautions, an attention to which will not fail to enable the amateur to purſue this modern diſcovery with expedience and economy.

The ſtuff uniformly made uſe of in the conſtruction of balloons to be raiſed by inflammable air is ſilk luſtring, (*taffetas luſtré,*) which is a ſubſtance extremely well calculated for the purpoſe, as poſſeſſing the valuable properties of cloſeneſs of texture and uncommon ſtrength, yet of little weight †: but the

* Finding Mr. Garnerin, notwithſtanding repeated applications, averſe to my accompanying him in the manner I propoſed, I adviſed him to take advantage of this eaſy method of ſecuring his machine; but he choſe rather to follow his own uncertain project of faſtening the neck of the balloon, in order that, as it afterwards continued to aſcend to a more rare atmoſphere, the force of the expanding inflammable air (thus prevented from eſcaping) might overcome the reſiſtance of the ſilk, and cauſe a rupture ſufficient to let out the gas: but in our ſmall iſland the machine might have been irrecoverably loſt in the ocean before theſe effects had taken place.

† Balloons to be raiſed by heated air are conſtructed of linen ſoaked in

the price of this silk, though more moderate in France, is in this country so high * as to augment the expense of a middling-sized balloon almost to a prohibition to any but the wealthiest individuals. I do not see, therefore, why strong cambric muslin, rinsed in drying oil †, (previous to sewing the pieces together,) should not fully answer every purpose. After providing the necessary quantity of the stuff, and each piece having been properly prepared with the drying oil, let the corresponding edges be sewed together in such a manner as to leave about half an inch of one piece beyond the edge of the other, in order that this may, in a subsequent row of stitches, be turned over the latter, and both again sewed down together: by so doing, a considerable degree of strength is given to the whole bag at the seams, and the hazard of the gas escaping doubly prevented. Having gone in this manner through all the seams, the following method of Mr. Blanchard is admirably calculated to render them yet more perfectly air-tight. The seam being doubly stitched as above, lay beneath it a piece of brown paper, and also another piece over it on the outside; upon this latter pass several times a common fire-iron heated just sufficiently to soften the drying oil in the seam: this done, every interstice will be now closed, and the seam rendered completely air-tight.

The neck of the balloon being left a foot in diameter and three in length, and all the seams finished, the bag will be ready to receive the varnish, a single coating of which on the

in a solution of alum or sal-ammoniac and common size: Mr. Cavallo recommends a gallon of water to a pound of each of the two ingredients: it may then be sewed into the required shape, and afterwards once varnished on the outside with merely drying linseed oil, adding a small quantity of neat's-foot oil to prevent its being sticky. The *liquor silicum*, or liquor of flints of the chemists, prepared by melting together one part of sand or powdered flints and four parts of fixed alkali, might, perhaps, be advantageously substituted for the saline ingredients above mentioned, as rendering paper or cloth varnished therewith perfectly incombustible.

* Silk lustring may be purchased on the continent at five shillings the yard, but here for not less than nine.

† In rendering oil drying for aërostatic purposes we should avoid the use of metallic oxides, as litharge, &c., which rot the stuff of the envelope; besides that hydrogen gas, by gradually reducing the metals, corrodes such varnish, turning it black, and in time causing it to crack. The best method to prevent these inconveniences is to allow the oil to stand for several weeks over unslaked lime, or to dissolve in it a small quantity of gum-sandarac, gum-lac, mastich, seed-lac, or common resin; all of which, when finely powdered, may be dissolved in linseed oil by well boiling, thus communicating to the oil the property of drying, yet retaining elasticity. Silk and canvas for umbrellas, &c. are varnished with a solution of either resin or gum-lac, melted with drying linseed oil to the consistence of a thick balsam, so as not to run about: thus varnished they are very little heavier than before, though impermeable to air or water.

outside

outside is found preferable to the former method of giving an internal as well as an external coat. The compositions for varnishing balloons * have been variously modified; but, upon the whole, the most approved appears to be the bird-lime varnish of M. Faujas St. Fond, prepared after Mr. Cavallo's method as follows:

"In order to render linseed oil drying, boil it, with two ounces of sugar of lead and three ounces of litharge † for every pint of oil, till they are dissolved, which may be in half an hour. Then put a pound of bird-lime and half a pint of the drying oil into an iron or copper vessel whose capacity should equal about a gallon, and let it boil very gently over a slow charcoal fire till the bird-lime ceases to crackle, which will be in about half or three quarters of an hour: then pour upon it two pints and a half more of the drying oil, and let it boil about an hour longer, stirring it frequently with an iron or wooden spatula. As the varnish whilst boiling, and especially when nearly done, swells very much, care should be taken to remove in those cases the pot from the fire, and replace it when the varnish subsides; otherwise it will boil over. Whilst the stuff is boiling the operator should occasionally examine whether it has boiled enough; which may be known by observing whether, when rubbed between two knives and then separated from one another, the varnish forms threads between them, as it must then be removed from the fire: when nearly cool, add about an equal quantity of spirit of turpentine: in using the varnish, the stuff must be stretched and the varnish lukewarm: in 24 hours it will be dry."

Every balloon should be provided with a valve so constructed as to open inwards, having also a spring to keep it shut. The string by which this valve is regulated must pass through a small hole in the lower part of the balloon to the car; its length must be such as to allow several coils of it to remain in the boat: this is a requisite precaution, as, when the inflammable air is much expanded, the horizontal diameter of the balloon is so much more extended, and its lower

* As the elastic gum, known by the name of Indian rubber, has been much extolled as a varnish, the following method of making it, as practised by Mr. Blanchard, may not prove unacceptable:—Dissolve elastic gum, cut small, in five times its weight of rectified essential oil of turpentine, (ethereal spirit of turpentine of the shops,) by keeping them some days together; then boil one ounce of this solution in eight ounces of drying linseed oil for a few minutes; strain the solution, and use it warm.

† The metallic oxides are less exceptionable in the outer varnish of a balloon than internally, as the first soaking in drying oil serves to shield the external varnish from the action of the gas.

pole

pole confequently drawn proportionably upwards, that the ftring of the valve will be otherwife out of the traveller's reach; an accident which has frequently obliged them to climb up into the netting to regain it. The valve itfelf fhould be covered with foft leather, reaching an inch or two beyond its edge every way. Its fituation fhould be upon the equator *, (and not, as generally directed, near the top,) elfe the lighteft gas will be that which will efcape; not to mention alfo the greater inconvenience in the latter cafe, arifing from the eftablifhment of a complete current of atmofpheric air through the balloon by the neck and valve together (the neck being generally left open a few inches), whereby a quantity of the lighter gas is carried off greater than one would imagine. To obviate this, the neck and valve fhould never be both open at one time; and I apprehend the accidents frequently occafioned by the ufually rapid defcent and rebounding of a balloon, are to be attributed to an inattention to this precaution; the gas being violently carried out of the valve by a current of air running through the balloon, and this current increafing with the velocity of the defcent; fo that, when the valve is again clofed, the balloon is found to have decreafed in levity much more than was wifhed for.

The car for balloons may be left to the option of the amateur, remembering that light weight, and the property of floating if defcending over water, be attended to.

[To be continued.]

LVII. *Extract from a Memoir on the Properties of Yttria Earth compared with thofe of Glucine; on the Foffils in which the former of thefe Earths is contained; and on the Difcovery of a new Subftance of a Metallic Nature.* By A. G. Ekeberg †.

THE firft part of this memoir contains an account of fome experiments, made by M. Ekeberg, to eftablifh the difference between glucine and the earth difcovered in the gadolinite, and called yttria or gadoline; but as the peculiar nature of each of thefe earths is already well known

* The opening of the valve being fometimes required during the rapid afcenfion of a balloon, and being followed alfo by a quick defcent, the equator is pointed out as the moft proper fituation in which to place the valve, to prevent the atmofpheric air from rufhing in either cafe into the balloon.

† From the *Tranfactions of the Academy of Sciences at Stockholm for* 1802, firft quarter.

to

to chemiſts, it is here needleſs to repeat what has been already ſaid on that ſubject.

As the other is intereſting on account of its novelty, we ſhall lay before our readers the obſervations made on it by the author.

Though the mineral ſubſtance I diſcovered, ſays he, contains yttria, it could not be claſſed in a ſyſtem of mineralogy as a ſpecies of earth, on account of the more abundant mixture it contains of another ſubſtance equally remarkable, and which muſt increaſe the claſs of metals, already very numerous. I found this ſubſtance in two foſſils, obtained from different places: in one of them, it was united with iron and manganeſe; and in the other, with the former of theſe metals and gadoline.

This new metallic ſubſtance is diſtinguiſhed by its inſolubility in all acids. The only re-agent which has any action on it is cauſtic fixed alkali. When ſubjected to heat with this alkali, if the maſs be then lixiviated, it partly diſſolves in the water, and ſuffers itſelf to be precipitated from that ſolution, by means of an acid—but without the precipitate being in any manner attacked, whatever be the quantity of the acid employed. When ſeparated by the filter, and dried, it remains under the form of an exceedingly fine white powder, which does not change its colour even at a red heat. If the remaining maſs be treated with acids, the ſame powder is obtained. Its ſpecific gravity, after being brought to red heat, is 6·500. It is fuſible by the blowpipe, by the addition of alkaline phoſphate and borate of ſoda; but communicates no colour to the flux.

Expoſed to a ſtrong heat in a crucible, without any other mixture than pounded charcoal, it is reduced to a button moderately hard, having ſome metallic ſplendour at its ſurface, but a dull blackiſh fracture. Acids have no other action on this kind of regulus, but that of bringing it to the ſtate of white oxide in which it was before. The circumſtances of the reduction, as well as the ſpecific gravity of this ſingular ſubſtance, ſeem to aſſign it a place among the metals, and I have ſufficient reaſons for being perſuaded that it is none of thoſe already known. The ſubſtances with which it might be confounded are the oxides of tin, tungſten, and titanium, which are ſoluble in cauſtic alkalies, and which, under ſome circumſtances, reſiſt acids. But the oxide of tin is eaſily diſſolved and reduced: tungſten immediately diſcovers itſelf by its ſolubility in ammonia, and by the blue colour which it communicates to phoſphate

phate of soda: the oxide of titanium gives a hyacinth colour to borax, and becomes soluble in acids by fusion with carbonate of potash*.

Before I describe the chemical analysis which I undertook of the two substances, which I consider as ores of the new metal, it is proper I should give a description of their external characters. In order to avoid circumlocution, when necessary to name them I shall venture to give them a generic denomination. Taking advantage of the usage which admits mythologic appellations, and to express the property which the new metal has, of not becoming saturated with the acids in which it is immersed, I shall apply to it the name of *Tantalus*. For the ore composed of tantalus, iron and manganese I propose the name of *tantalite*; and for the ore containing yttria, that of *yttrotantalite*, which will not be found longer than that of *siderotitanite*.

The specimen of tantalite was given to me by M. Geeger, director of the mines; who assured me that this substance has been known since 1746, and considered as a problematic variety of the garnet of tin, (*zinngraupen*.) It is found near the farm of Brokaern, in the parish of Kimito, and government of Abo, in Finland, in a large mountain on the borders of the Baltic. The matrix is composed of white quartz and mica, with veins of red feldspar in large laminæ; matters of which the sides of the vein are formed: the titanite is found dispersed throughout it, in the form of garnet.

What I saw was in detached crystals, of the size of a walnut, and the best defined seemed to approach the octaedral form; they were charged with parcels of feldspar and mica.

Its surface is smooth, shining, and blackish.

Its fracture is compact, and has a certain metallic splendour: the colour of the fracture is not every where the same; it varies between grayish blue and the black of iron.

When powdered, it is blackish gray inclining a little to brown.

It has sufficient hardness to strike fire with steel.

I have not observed that it has any attraction for the magnet.

Its specific gravity is 7·953.

The yttrotantalus is found in the same place and in the same matrix as the gadolinite. Klaproth says that the latter is

* I had, however, entertained some suspicions in regard to the identity of the new substance and the last-mentioned metal; and I was not fully convinced of its not existing, but by comparing it with the titanized iron of Norway, which I decomposed for that purpose.

is found incrufted in a granitic mafs: but though the conftituent parts of granite are found there from time to time, it is no lefs certain that the real matrix is nothing elfe than feldfpar, as is evidently feen in the large mine of Ytterley. The mica and quartz found there form diftinct parts, and do not enter into combination with the feldfpar*; but in general it is a rock of feldfpar, interfected by large veins of mica, in a direction almoft perpendicular; and it is in the proximity of thefe veins that the gadolinite as well as the yttrotantalus muft be fought for. The firft is generally found attached on one fide to a vein of argenteous mica, and the reft of its volume enveloped by feldfpar. The fecond never adheres immediately to the mica. The clumps (*rognons*) which it forms, become enveloped with a thin cruft of feldfpar, feparate from the grand mafs by thin ftrata of grayifh black mica. The veins charged with thefe *rognons* are rarely infulated; feveral of them are found together, feparated only from each other, and from the principal rock, by fimilar fides of mica. It was thus that I for the moft part found thefe fubftances placed by nature, and it is very rarely that they are found in grains diffeminated throughout the rock of feldfpar.

The largeft *rognons* which I found of the ore of the yttrotantalus had not attained to the fize of a walnut. The fracture of them was granulated, of an iron black colour, with a metallic fplendour.

Its hardnefs is not confiderable; it can be fcraped by means of a knife, but with difficulty.

When powdered it is of a grayifh colour.

It exercifes no action on the magnet.

I found its fpecific gravity to be 5·130; but as it was not poffible for me to find a piece entirely free from feldfpar, I fufpected that its real gravity muft be a little more confiderable.

We fhall terminate this extract by a fhort view of that part of M. Ekeberg's memoir, which relates to the analyfis of the gadolinite, and the comparifon of the yttria with glucine, which in feveral works has been confidered as being of the fame nature.

Gadolinite, when pure, is fufficiently compact to ftrike fire with fteel.

It is found cryftallized in an imperfect manner, like fome kinds of garnets.

It contains glucine.

* I fpeak here only of the maffes of the principal rock, without denying the poffibility of finding there fome fragments in which the three fubftances are intermixed.

Befides

Befides the diftinctions eftablifhed by Klaproth and Vauquelin between the gadoline and glucine, thefe two earths appear to be different by the following peculiar properties:

The fpecific gravity of gadoline differs confiderably from that of glucine, which is only 2·967, while that of gadoline is 4·842. The laft earth is the heavieft of all the earthy fubftances known, fince it furpaffes by 0·482 the gravity of barytes, which weighs only 4·000.

It is foluble in alkaline carbonates.

It is abfolutely infoluble in cauftic alkalies.

It is not, like glucine, precipitated by fuccinates.

LVIII. *Obfervations on the Change which Carbonic Acid Gas experiences by the Electric Spark, and on the Decompofition of the fame Gas by Hydrogen Gas.* By THEODORE DE SAUSSURE*.

I. *Change which Carbonic Acid Gas experiences by the Electric Spark.*

DR. PRIESTLEY had obferved that carbonic acid gas dilated by the electric fpark, and experienced a modification which prevented it from being entirely abforbed by lime water, or by alkalies. C. Monge examined with the greateft care what took place in this experiment, and found that the gas produced by electrifation was inflammable gas. I fhall here defcribe in a few words the principal refults of this obfervation: A column of carbonic acid gas, of 34 inches, contained by mercury, rofe to 35 inches and a half, after having been traverfed for a long time by electric fparks, which circulated between iron conductors. It could not be dilated any more by further electrifation. The wires as well as the mercury were oxidated. Potafh could only abforb 21 inches and a half of this column of acid gas: the remaining 14 inches were inflammable gas. C. Monge accounts for thefe phænomena by fuppofing that the carbonic acid gas does not experience the leaft alteration in its principles, and he reafons nearly as follows: The conductors and the mercury, by decompofing the water held in folution in the carbonic acid gas, produce two oppofite effects, of which nothing is obferved but the difference. 1ft. The volume of the acid gas is diminifhed, by being deprived of the water which it held in folution. 2d. The volume of the elaftic fluid is augmented, by the development of the hydrogen gas of the water de-

* From the *Journal des Mines*, No. 68.

compofed:

composed. The residuums of gas after the operation are a mixture of hydrogen gas, resulting from the decomposition of the water, and carbonic acid gas deprived of water.

This very ingenious explanation* was without doubt the only one which could present itself at the time when it was given. Had it been just, it would have been necessary, by restoring to the acid gas condensed by desiccation the water it had lost, to dilate it again, and to augment about 12 inches the column in question. As C. Monge did not submit his explanation to this decisive proof, I thought proper to attempt it.

I caused to circulate for 18 hours electric sparks in the bulb of a matrass which contained 13 cubic inches of pure carbonic acid gas, and without any mixture of water superabundant to that which it might naturally hold in solution. The mercury, in which the inverted matrass was immersed, rose to about the half of its neck. After electrisation, the metallic fluid was found oxidated black, as had been observed by Monge and Priestley; but my conductors, which were of copper, were not sensibly altered. The elastic fluid had experienced a small dilatation, which appeared to me not to exceed the tenth part of a cubic inch. I then made about a grain of water† to pass in contact with the aëriform gas contained in the matrass. I let it remain there for several days, without perceiving any dilatation in the volume of the gases, the residua of the operation. I then moistened, with a drop of water which I introduced, the whole inside of the matrass—but in vain—the mercury constantly remained at the same height. I however found, on absorbing by potash the residuum of the acid gas, that a cubic inch of carbonic acid gas had disappeared, and had been replaced by a quantity nearly equal, or rather superior, to the inflammable gas. The 20 cubic centimetres occupied in the neck of the matrass a column four inches in length; and the acid gas, had the supposed explanation been just, would have been dilated

* It supposes that the carbonic acid gas may hold in solution a great quantity of water. But this assertion is not proved by any other direct experiment. Dr. Priestley was not able to calcine carbonate of barytes but by the help of a current of aqueous vapour, which he caused to circulate on that earth brought to a red heat. This result may be explained by the affinity alone of the water for the barytes. It is besides possible that the carbonic acid gas dissolves at a red heat a certain quantity of water, and dilates much in this solution, without producing these effects at the temperature of the atmosphere.

† It is needless to observe here, that water can absorb no more than its own volume of acid gas with the pressure of the atmosphere, and that the drop of water introduced into the matrass could not produce by this absorption any sensible change in the volume of the elastic fluid.

 through

through all that ſpace. I then thought that this inflammable gas did not ariſe from the decompoſition of the water, but from that of the carbonic acid itſelf by the metal. I indeed found that this gas was not hydrogen gas, but carbonous gas perfectly pure. I burnt 100 parts of it on mercury, with about a third of oxygen gas. I did not perceive water after this combuſtion, which left for reſiduum 77 parts of carbonic acid gas.

The dilatation which the latter experiences by electriſation may be explained by the different denſities of the carbonous gas and the carbonic acid gas. I was not able to verify the obſervation of C. Monge reſpecting the dilatation experienced by the carbonic acid gas, after electriſation over mercury.

If it was not poſſible to reduce entirely the acid gas into carbonous gas by theſe proceſſes, it was becauſe the firſt ſtrata of metallic oxidation preſented an obſtacle to further oxidation, by preventing the points of contact. The development of the carbonous gas produced therefore an analogous effect.

It reſults then from my obſervations, that the change which carbonic acid gas undergoes by electriſation does not ariſe from the decompoſition of the water, but from the partial decompoſition of the carbonic acid gas, which becomes carbonous gas, giving up a part of its oxygen to the metal introduced in theſe experiments.

II. *Decompoſition of Carbonic Acid Gas by Hydrogen Gas.*

It was long ſuppoſed that carbonic acid gas could be decompoſed by hydrogen gas; but no one was able to effect it, though many experiments were made on that ſubject. I had obſerved, that a mixture of equal parts of hydrogen gas and carbonic acid gas, contained by mercury and left to itſelf, had decreaſed in volume in the courſe of a year. When I then cauſed the reſiduum of acid gas to be abſorbed by potaſh, and had burnt the hydrogen gas, I found that there was formed in this combuſtion carbonic acid gas: but theſe reſults were not very ſenſible; and what took place in this operation was to me mere conjecture. Since that time I have been able to confirm in a deciſive manner this firſt obſervation, by cauſing the electric ſparks to circulate in a mixture of carbonic acid gas and hydrogen gas. In a few moments I ſaw the volume of the gas decreaſe, drops of water formed, and the acid gas paſs almoſt entirely to the ſtate of carbonous gas. The following are the details of one of theſe experiments: I introduced into a cylindric glaſs jar

 about

about nine lines in diameter, and clofed by mercury, a mixture of four parts in volume of carbonic acid gas, and three parts of hydrogen gas. The fpace occupied by the two aëriform fluids united formed a long column of feven inches, fo that each part in volume of the glafs correfponded to one inch in length of the column. I caufed the electric fpark to circulate by iron conductors. The condenfation of the gas, which at firft took place very rapidly, became always flower; after twelve hours electrifation, its progrefs was almoft infenfible. The very fine drops of water, formed during the operation in the upper part of the tube, difturbed its tranfparency. The column of aëriform fluid was reduced to four inches. It then experienced in its length a diminution equal to three inches. I then introduced into it potafh, which could abforb only one inch of carbonic acid gas. The three remaining inches were carbonous gas almoft pure. I burned by means of the electric fpark, 100 parts of it with oxygen gas, and they left for refiduum 64 parts of carbonic acid gas.

It is feen, then, that three inches of carbonic acid gas were decompofed, and paffed to the ftate of carbonous gas, by combining a part of their oxygen with the hydrogen gas introduced. It is feen alfo that the latter, by lofing the elaftic ftate to form part of the water refulting from this combination, produced the condenfation obferved in the volume of the two gafes.

It is to be remarked, that the mercury and conductors in this experiment were not confiderably oxidated.

It has long been obferved, that hydrogen gas, confined by water in contact with atmofpheric air, decreafes very flowly in volume, and then burns with a flame lefs vivid. It has been fuppofed that this gas filters through the water in the atmofphere; but there is nothing to fupport this explanation. In my opinion, it is more probable that the carbonic acid gas of the atmofphere filters alone through the water, according as it is decompofed by the hydrogen gas, which decreafes in the ratio of this decompofition.

LIX. *Some Account of* Richard Kirwan, *Esq. LL. D. F. R. S. and P. R. I. A.*

THIS gentleman, who has diftinguifhed himfelf fo much by his philofophical and geological labours, was bred to the law, and exercifed his profeffion as a barrifter, till infirm health, and the death of his elder brother, a member of the Irifh parliament, occafioned him to become an experimental inquirer.

inquirer into the phænomena of nature. Having devoted his attention to chemiſtry and natural philoſophy, he ſet out in this new mode of life, in or near London, about the year 1779 or 1780. He made his debut with ſome papers read in the Royal Society, for which he received the Copley medal, about the year 1781. The titles of theſe papers are as follow:—Experiments and Obſervations on the Specific Gravities and Attractive Powers of various Saline Subſtances: read Nov. 16, 1780.—Continuation of theſe Experiments and Obſervations: read April 11, 1782.—Concluſion of the Experiments and Obſervations concerning the Attractive Powers of the Mineral Acids: read Dec. 12, 1782.—Remarks on Mr. Cavendiſh's Experiments on Air: read Feb. 5, 1784.—Remarks on Specific Gravities, taken at different Degrees of Heat; and an eaſy Method of reducing them to a common Standard: read Feb. 17, 1785.—Experiments on Hepatic Air: read Dec. 22, 1785.

Mr. Kirwan returned to his native country about the year 1789, and ſome time after was appointed Preſident of the Royal Iriſh Academy; a place which he continues to hold, with honour to himſelf and advantage to the philoſophical world. The papers with which he has enriched the Tranſactions of the learned body over which he preſides are: An Eſſay on the Variations of the Barometer: read March 1, 1788.—Obſervations on Coal Mines: read Jan. 10, 1789.—Experiments on the Alkaline Subſtances uſed in Bleaching; and on the Colouring Matter of Linen Yarn: read April 4, 1789.—On the Strength of Acids and the Proportion of Ingredients in Neutral Salts: read Dec. 24, 1790.—A Comparative View of Meteorological Obſervations made in Ireland ſince the Year 1788, with ſome Hints towards forming Prognoſtics of the Weather: read Feb. 2, 1793.—Reflections on Meteorological Tables, aſcertaining the preciſe Signification of the Terms Wet, Dry, and Variable: read July 23, 1793.—State of the Weather in Dublin from the 1ſt of June 1791 to the 1ſt of June 1793.—Examination of the ſuppoſed Igneous Origin of Stony Subſtances: read Feb. 3, 1793.—Eſſay in Anſwer to the following Queſtion, propoſed by the Royal Iriſh Academy: What are the Manures moſt advantageouſly applicable to the various Sorts of Soils, and what are the Cauſes of their beneficial Effect in each particular Inſtance? read Jan. 4, 1794.—Meteorological Obſervations made in Ireland in the Year 1793: read Jan. 25, 1794.—Experiments on a New Earth found near Stronthian in Scotland: read Jan. 9, 1794.—Of the Compoſition and Proportion of Carbon in Bitumens and Mineral Coal: read Dec. 19, 1795.—

1795.—Synoptical View of the State of the Weather in Dublin: read Jan. 9, 1796.—Thoughts on Magnetism: read March 19, 796.—On the Primitive State of the Globe, and its subsequent Catastrophe: read Nov. 19, 1796.—Synoptical View of the State of the Weather at Dublin in the Year 1796.—Synoptical View of the State of the Weather at Dublin in the Year 1797.—Additional Observations on the Proportion of real Acid in the three antient known Mineral Acids, and on the Ingredients in various Neutral Salts and other Compounds: read Dec. 16, 1797.—Essay on Human Liberty: read July 28, 1798.—Synoptical View of the State of the Weather at Dublin in the Year 1798.—Synoptical View of the State of the Weather at Dublin in the Year 1799.—Observations on the Proofs of the Huttonian Theory of the Earth, adduced by Sir James Hall: read Feb. 8, 1800.—An Illustration and Confirmation of some Facts mentioned in an Essay on the Primitive State of the Globe: read May 5, 1800.—An Essay on the Declivities of Mountains: read April 28, 1800.—Of Chemical and Mineralogical Nomenclature: read March 24, 1800.—Remarks on some Sceptical Positions in Mr. Hume's Inquiry concerning the Human Understanding, and his Treatise of Human Nature: read October 20, 1800.—Synoptical View of the State of the Weather at Dublin in the Year 1800.—Of the Variations of the Atmosphere: read May 11, 1801.—Synoptical View of the State of the Weather at Dublin in the Year 1801.

Mr. Kirwan is also the author of the following works: Essay on Phlogiston; Elements of Mineralogy, 2 vols.; Geological Essays; Essay on the Analysis of Mineral Waters; and (in the present volume) A Reply to Mr. Playfair's Reflections on Mr. Kirwan's Refutation of the Huttonian Theory of the Earth; and an Illustration and Confirmation of some Facts mentioned in an Essay on the Primitive State of the Globe.

LX. *Observations on the Law of the Expansion of Water at Temperatures below 42°; extracted from a Paper on the Power of Fluids to conduct Heat.* By John Dalton*.

My first attempt was to ascertain the precise degree of cold at which water ceases to be further condensed, and likewise how much it expands in cooling below that degree to the temperature of freezing, or 32°. For this purpose I took a thermometer tube, such as would have given a scale of 10

* From *Journals of the Royal Institution of Great Britain.*

 inches

inches with mercury from 32° to 212°, and filled it with pure water. I then graduated it by an accurate mercurial thermometer, putting them together into a bason filled with water of various degrees of heat, and stirring it occasionally. As it is well known that water does not expand in proportion to its heat, it does not therefore afford a thermometric scale of equal parts, like quicksilver.

From repeated trials agreeing in the result, I find that the water thermometer is at the lowest point of the scale it is capable of, that is, water is of the greatest density, at $42\frac{1}{2}$° of the mercurial thermometer. From 41° to 44° inclusively the variation is so small as to be just perceptible on the scale; but above or below those degrees the expansion has an increasing ratio, and at 32° it amounts to 1-8th of an inch, or about $\frac{1}{170}$th part of the whole expansion from $42\frac{1}{2}$° to 212°, or boiling heat. During the investigation of this subject, my attention was arrested by the circumstance, that the expansion of water was the same for any number of degrees from the point of greatest condensation, no matter whether above or below it: thus, I found that 32°, which are $10\frac{1}{2}$° below the point of greatest density, agreed exactly with 53°, which are $10\frac{1}{2}$° above the said point; and so did all the intermediate degrees on both sides. Consequently, when the water thermometer stood at 53°, it was impossible to say, without a knowledge of other circumstances, whether its temperature was really 53° or 32°. Recollecting some experiments of Dr. Blagden in the Philosophical Transactions, from which it appears that water was cooled down to 21° or 22° without freezing, I was curious to see how far this law of expansion would continue below the freezing point, previously to the congelation of the water, and therefore ventured to put the water thermometer into a mixture of snow and salt, about 25° below the freezing point, expecting the bulb to be burst when the sudden congelation took place. After taking it out of a mixture of snow and water, where it stood at 32° (that is 53° per scale), I immersed it into the cold mixture; when it rose, at first slowly, but increasing in velocity, it passed 60°, 70°, and was going up towards 80°, when I took it out to see if there was any ice in the bulb—but it remained perfectly transparent. I immersed it again and raised it to 75° per scale, when in an instant it darted up to 128°; and that moment taking it out, the bulb appeared white and opaque, the water within being frozen. Fortunately it was not burst; and the liquid which was raised thus to the top of the scale was not thrown out, though the tube was unsealed. Upon applying the hand, the ice was melted, and the liquid resumed its station.

7 This

This experiment was repeated and varied, at the expenfe of feveral thermometer bulbs; and it appeared that water may be cooled down in fuch circumftances, not only to 21°, but to 5 or 6°, without freezing, and that the law of expanfion above mentioned obtains in every part of the fcale from $42\frac{1}{2}$° to 10° or below; fo that the denfity of water at 10° is equal to the denfity at 75°.

LXI. *Remarks on certain Properties of Barytes in its Combination with Mineral Acids; and on two new Salts never before defcribed.* *By* J. HUME, *Efq.**

FROM a number of experiments I have occafionally made on *barytes,* but chiefly on it when combined with mineral acids, I have been led to draw fome conclufions and obferve phænomena, which, I believe, have hitherto been either totally unknown, or fo very imperfectly detailed, as, no doubt, to have frequently been a fource of error. This earth, for I am not yet difpofed to clafs it with alkalies, certainly poffeffes peculiar habitudes, or rather, when compared with thofe of other earths and alkalies, and its own combinations compared with each other, fome fingular anomalies, which I have never yet feen pointed out by chemical writers. Amongft many others, the following appear the moft prominent, and therefore demand firft to be noticed.

1. That fulphate of barytes is completely *foluble* in fulphuric acid; forming a faline *fluid* or acidulous fulphate, analogous, in fome of its characters, to phofphate of lime and many other falts, with capacity for excefs of acid; decompofable by water alone, which returns it to fimple fulphate; and this falt never has been enumerated by any author.

2. That carbonate of barytes is alfo totally decompofed by, and foluble in, fulphuric acid, forming, of courfe, the fame *acidulous* fulphate. Refpecting any figure this new falt may put on, I have not yet been able fully to determine; but I ftrongly fufpect it may, under particular circumftances, be made to cryftallize.

3. That nitrate of barytes, not in cryftals only, but even a faturated aqueous folution, is perfectly *infoluble* in nitrous acid of the ufual fpecific gravity.

4. That carbonate of barytes may entirely be changed into nitrate by nitrous acid in its *concentrated* ftate. The converfe of this has hitherto been maintained.

* Communicated by the Author.

5. That muriate of barytes is virtually *infoluble* in muriatic acid.

6. That carbonate of barytes may be rendered into muriate by *concentrated muriatic acid.*

7. This may not appear to be, with propriety, placed after the others; it ought neverthelefs to be named, fince no author has given any account of it. It is, that fulphate of ftrontian has alfo a capacity for fuper-faturation; forming, like No. 1, an acidulous fulphate in *folution*, and decompofable by water.

In feveral chemical works, written by very eminent men, I have frequently obferved fome of the above refults very nearly accomplifhed; and have been amazed to find fuch palpable truths had efcaped their notice: yet, on a careful examination of the context, I confefs, I could never find a fingle proof that any one of thefe peculiarities of barytes has been known to the full extent as above detailed. In refpect to No. 1, there is no mention of an *acidulous* fulphate nor of *fluidity*, in an effay, where I expected to find it, written in 1790 by C. Fourcroy *. It may alfo be remarked, that in a more modern work by the fame very excellent chemift, fpeaking of fulphate of barytes, he expreffes himfelf thus: "Il paraît cependant diffoluble par des *moyens* que la nature nous *cache* encore, puifqu'il eft vifiblement criftallifé par l'eau. On ne peut pas le faire criftallifer artificiellement †." The fame author had affirmed the perfect infolubility of carbonate of barytes in nitrous (or nitric, for it is not yet decided) acid: "L'acide nitrique le plus concentré n'a abfolument aucune action fur le carbonate de barite natif en morceau, ce fel y refte intact abfolument comme dans l'eau ‡." This is quite contrary to the refult of my experiments, even with little more heat being employed than the common atmofpheric temperature. Indeed, regarding the effect of mineral acids upon the native carbonate of witherite, for it would be unfair, in this place, to fpeak of *artificial* carbonate, the fame author fums up his opinion in one fentence: "Que les acides ne l'attaquent point en maffe, et lorfqu' ils font concentrés §." Since no part of this analyfis has yet been re-

* Analyfe de Carbonate de Baryte natif, &c. § 3.

† Syftême des Conn. Chimique.—" It, however, appears to be foluble by *means* which nature ftill *conceals* from us, fince it is evidently cryftallized by water. It cannot be made to cryftallize artificially."

‡ Ibid. " The moft highly concentrated nitric acid has abfolutely no action on native carbonate of barytes in bits. This falt remains in it abfolutely unattacked, as in water."

§ Analyfe, &c. § 4.—" That the acids do not attack it in a mafs, and when they are concentrated."

tracted,

tracted, but, on the contrary, if poſſible, more completely confirmed by the author's writings ſince that period, I have been leſs ſcrupulous in applying theſe quotations to my purpoſe. Though another author has, in one ſolitary ſentence, apparently flatly contradicted C. Fourcroy, yet, on a cloſer inſpection of the work, (2de édition *conſidérablement augmentée,*) which I ſhould call a *third* edition, it does not appear that any one of theſe habitudes or anomalies has been clearly demonſtrated to exiſt. The ſentence is, to ſay no more of it, evidently conditional, and no mention made either of *concentration* or *dilution*: "Tous les acides minéraux decompoſent ce ſel," (*meaning* carbonate de barite *.) But my doubts were completely removed, at leaſt reſpecting what I have ſtated at Nos. 3 and 4, when I read a whole page †, where we find detailed a moſt circuitous proceſs for purifying nitrous acid by litharge and nitrate of ſilver.

I purpoſely forbear to mention any method I purſued to accompliſh each combination; as it appears to me to be within the limits of the meaneſt capacity, and obvious to every chemiſt to obtain the ſame reſults.

No. 108, Long Acre,
January 24, 1803.

LXII. *On the Utility of Pruſſiate of Copper as a Pigment.* *By* Charles Hatchett, *Eſq. F.R.S.* ‡

THE accidental diſcovery made by Dieſbach of the pigment called Berlin or Pruſſian blue, about the year 1710, and which afterwards was publiſhed by Woodward in the Philoſophical Tranſactions for 1724, was ſoon adopted by artiſts and manufacturers, ſo that in a ſhort time the great utility of this colour was completely eſtabliſhed: it is therefore remarkable, that but little attention has been ſubſequently paid to the colorific properties of the other metallic pruſſiates.

The experiments made by Mr. Brown with the pruſſic lixivium on various metallic ſolutions do not merit particular attention, as the reſults evidently ſhow that a very large portion of the alkali remained unſaturated with pruſſic acid, and thus the effects appeared different when the lixivium was prepared with blood or with muſcle §.

Bergman has, however, more accurately examined the pro-

* Analyſe, &c. § 7.—"All the mineral acids decompoſe this ſalt."
† Manuel d'un Cours de Chimie, *La Grange*.
‡ From Journals of the Royal Inſtitution of Great-Britain.
§ Philoſophical Tranſactions 1724, p. 17.

 perties

perties of metallic precipitates, (Opuſcula, tom. ii. p. 385), and eſpecially notices the various colours of the pruſſiates; but neither he nor any other chemiſt, as far as I am acquainted, has pointed out to artiſts the utility of pruſſiate of copper as a pigment. During ſome late experiments, I was much ſtruck with the beauty of this precipitate, and was therefore induced to make ſeveral trials of it as a paint: the reſults exceeded my moſt ſanguine expectations. I afterwards prepared a large quantity, which at my requeſt ſeveral gentlemen (particularly B. Weſt, eſq. P.R.A., John Trumbull, eſq., and ſir H. C. Englefield,) were ſo obliging as to try in oil, and in water; and I have had the ſatisfaction to learn, that in beauty and intenſity it ſurpaſſes every brown paint now in uſe, with the additional advantage, that, by reaſon of its purple tint, it forms with white various ſhades of bloom or lilac colour, which do not appear liable to fade like thoſe which are formed by means of lake.

The pruſſiates obtained from acetite, ſulphate, nitrate, and muriate of copper, are all very beautiful; but the fineſt and deepeſt colour is afforded by the muriate. I have found alſo that pruſſiate of lime can be better depended upon for this purpoſe than pruſſiate of potaſh. The beſt mode, therefore, of forming this pigment, is to take green muriate of copper, diluted with about ten parts of diſtilled or rain water, and to pour in pruſſiate of lime until the whole is precipitated: the pruſſiate of copper is then to be well waſhed with cold water on the filter, and to be dried without heat.

LXIII. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

An account of a journey to the ſummit of Whararai, a mountain in the iſland of Owhyhee, by Mr. Archibald Menzies, naturaliſt on board the Diſcovery, captain Vancouver, was read on the 9th and 16th of December.

In January 1799, the Diſcovery, being ſtationed in Karakakooa bay, Mr. Menzies was deſirous of making a botanical excurſion into the iſland of Owhyhee, in company with ſome other gentlemen of the expedition, and, in particular, of aſcending a conical mountain in the neighbourhood, called Wharaṛai. For this purpoſe he was furniſhed with a numerous company of attendants by the king of the iſland, under the command of one of the chiefs, who was made reſponſible for his ſafety, and for his perfect accommodation with proviſions of all kinds, and who executed his taſk with as much fidelity

fidelity as the whole troop performed their labours with alacrity. Mr. Menzies had a portable barometer of a ſimple conſtruction, by which he aſcertained the height of different places as accurately as the time would allow. The iſland appeared to be in general in a ſtate of high cultivation: the proviſions for the journey conſiſted of live hogs, poultry, dried fiſh, yams, and cocoa-nuts, in quantities that loaded more than twenty men. They left the ſea-ſide the 17th of January, after coming by water to the foot of the mountain, the barometer ſtanding at 30·10, the thermometer at 81°, at noon. The road was through lava and other volcanic productions for about three miles: here the plantations of bread-fruit trees began, and the country was fertile and pleaſant; the night was paſſed in the uppermoſt village, conſiſting of a few ſcattered huts. Beyond this was a thick foreſt, ſkirted by fruitful plantations of bananas and plantains: about three miles within the foreſt, the elevation appeared to be 2600 feet above the ſea. The thermometer was 59°, at noon. The natives conſtructed a number of ſmall huts, which afforded ſhelter to the whole party for the night at the upper extremity of the foreſt. Here the thermometer was at 58°, in the evening: the uniformity of temperature at heights conſiderably different, Mr. Menzies attributes to the ſhelter of the foreſt, and the evaporation from the trees. But the next morning the thermometer was at 43°. The ſummit of the mountain was rugged and barren: Mr. Menzies arrived at it in a few hours from the laſt ſtation. It afforded a very extenſive view of the iſland, although parts of it were hidden by clouds: its moſt conſpicuous features were two other mountains, of which the ſummits are covered with perpetual ſnow, bearing E.N.E. and S.E. by E. of Wharara. On this hill there is a very deep crater of a volcano, with aſhes and cinders appearing quite freſh: the natives conſider it as the habitation of evil ſpirits, whom they attempt to pacify by offerings of various kinds. The party of travellers ſpent the whole of this and the following day on the mountain, and paſſed the night in caverns thatched with plantain leaves, and ſtrewed with graſs and mats for the occaſion. The ſophora tetraptera was in flower, as a ſmall ſhrub; in the lower parts of the iſland it becomes a tree, of which the natives make their ſpears, and which takes a fine poliſh. The dodonæa viſcoſa thrived on the ſummit of the hill; and a ſmall ſhrubby geranium was found there. The height appeared to be 8000 feet above the ſea. The thermometer was lower at ſun-ſet than at ſeven in the morning.

Mr. Menzies deſcended on the ſouth-eaſt ſide of the hill,

and

and arrived in the afternoon at a deep cavern, where he paſſed the night. Hence he made a fruitleſs attempt to aſcend the ſnow-clad mountain, on the other ſide of the valley, in which the natives accompanied him with the greateſt reluctance: the ſame cavern received him the following night. The centre of the iſland between the three mountains is barren and uninhabited: it appears to be elevated about 5000 feet above the ſea. Returning towards the ſhore, the party arrived the next evening at a village nine or ten miles from Karakakooa bay, ſurrounded by fields and plantations in the higheſt poſſible ſtate of cultivation; its elevation appeared to be about 2000 feet. Here they were entertained by an exhibition of much grace and great activity in the performance of a female dancer belonging to a ſtrolling party. The next day was the laſt of the excurſion; and the natives were diſmiſſed with rewards of knives, files, ſciſſars, looking-glaſſes, and tape, of which a ſmall portion was ſurrendered by each to the king. The barometer now ſtood at 30·12, and the thermometer at 74°.

On the 13th of January the Society reſumed its ſittings after the Chriſtmas holidays. An intereſting paper, by Charles Hatchett, eſq. on the alloying of metals, was read on that evening, and continued on the evening of the 23d. It reſults from his experiments that platina ſhould not be employed as an alloy for gold, as it makes the gold aſſume a white colour. A number of experiments were made with pieces of gold coin, to aſcertain the effects of the exceſs of motions ſimilar to what they experience by rubbing in the pocket, and by being tranſported from one place to another. By theſe it was found, that copper in the proportion of 1-12th was the beſt alloy for gold; and that the deficiency found of late in the gold coin was not owing to the wear of circulation, as, in a quantity of guineas rather looſely packed, and ſent to ſome diſtance by the coach, the wear was all upon a few, and on thoſe the impreſſion was quite obliterated: yet they were not found much deficient in weight, the work being by the action preſſed in, and not as it were filed off.

ROYAL SOCIETY OF EDINBURGH.

This learned body has publiſhed the ſecond part of the fifth volume of its Tranſactions, which preſents the following papers:—Remarks on a mixed Species of Evidence in Matters of Hiſtory; with an Examination of a new Hiſtorical Hypotheſis in the *Mémoires pour la Vie de Petrarque*: by the Abbé de Sade: by Alexander Fraſer Tytler, eſq.—Deſcription of an Extra-uterine Fœtus; by Mr. Thomas Blizzard,

zard.—Meteorological Abſtract for the Years 1797, 1798, and 1799; by Mr. Playfair.—A new and univerſal Solution of Kepler's Problem; by James Ivory, Eſq.—Deſcription of ſome Improvements in the Arms and Accoutrements of Light Cavalry, &c.; by the Earl of Ancrum.—A new Method of expreſſing the Co-efficients of the Development of the Algebraic Formula $(a^2 + b^2 - 2ab \text{ coſ. } \varphi^n)$, by means of the Perimeters of two Ellipſes, when n denotes the half of any odd Number; with an Appendix, containing the Inveſtigation of a Formula for the Rectification of any Arch of an Ellipſe: by Mr. William Wallace.—Chemical Analyſis of an uncommon Species of Zeolite; by Dr. Robert Kennedy.

ROYAL SOCIETY OF GOTTINGEN.

The following prize queſtion has been propoſed for the year 1804:

As many obſervations and theories reſpecting the nature, principles, and laws of atmoſpheric phænomena, which if ſubjected to proof and more accurately known might be of great importance and utility in improving the preſent ſyſtem of meteorology, are contained in the works of the old and modern naturaliſts of the 16th century, the Society requires a hiſtory of meteorology from the time of the Greeks and Romans to the preſent period, drawn from authentic ſources, and materials ſelected with critical attention to the object in view. The prize will be 50 ducats, and the papers muſt be tranſmitted to the ſociety before the month of September of the above year.

LXIV. *Intelligence and Miſcellaneous Articles.*

FROM PROFESSOR PICTET.

Paris, January 1, 1803.

PROFESSOR PICTET preſents his moſt ſincere reſpects to Mr. Tilloch, and embraces the opportunity of a friend to ſend him one or two communications, which may prove intereſting.

In the ſitting of the National Inſtitute of December 29, a letter was read from M. Mollet, profeſſor of natural philoſophy at Lyons, in which he announced two facts which appear to be new. The firſt is the appearance of a ſmall light in the air which ſurrounds the orifice of an air-gun when

when difcharged in the dark. This experiment does not always fucceed; and the caufe of the differences obferved in this refpect is not yet known.

The fecond fact is the inflammation of any combuftible matter, fuch as a fmall bit of linen rolled up, when put into the narrow canal in which the lower extremity of a pump for condenfing the air generally terminates. Two or three ftrokes of the pifton are fufficient to inflame it, according as the current of air produced is more or lefs rapid.

In the fame fitting M. Seguin concluded a memoir, which he had announced in the preceding, on the difcovery he pretends to have made of a new febrifuge principle, abfolutely different from any of thofe before employed with greater or lefs fuccefs. He confiders it as much fuperior to cinchona, on account of the certainty of its effects, and the facility with which it can be procured. This febrifuge is nothing elfe than *gelatine*, or common ftrong glue. He purifies it, mixes it with a little fugar and orange flower water, and rolls it out into large cakes, which he cuts into fmall fquares of the fize of an inch, weighing about a gros. The dofe is from two gros to thirty-two, according to the age and circumftances of the patient. It is diffolved in water in fuch a manner that the beverage retains a confiderable degree of confiftence; and it is fwallowed at once when the fit comes on. The fame thing is repeated at the next fit, and it is feldom neceffary to take a third.

The author has mentioned a number of perfons to give teftimony of the fuccefs of this remedy, all from the individuals who depend on his vaft eftablifhments of tanning and agriculture.

The Inftitute has appointed a commiffion, compofed of Berthollet, Fourcroy, Des Effarts, and Portal, to examine the memoir, and give in a report on it after repeating the experiments.

M. Seguin has announced a feries of memoirs, in which he fays he will develop the whole theory of fever, determine what is the febrile principle properly fo called, and what is the mode of action of febrifuge medicines. The refults are waited for with a mixture of impatience and doubt.

GALVANISM.

Profeffor Aldini repeated his experiments on Galvanifm at the Anatomical Theatre, St. Thomas's Hofpital, during the laft month. As the profeffor does not fpeak the Englifh language, Mr. Aftley Cooper explained to the gentlemen prefent. The Galvanic troughs, confifting of 120 pairs of filver

ſilver and zinc plates, of two inches ſquare, with the metallic communications, were under the direction of Mr. Pepys jun.

The firſt ſeries of experiments was on frogs. The head being ſevered, the ſciatic nerves and the whole of the muſcles of the thighs and legs were laid bare; a portion of the vertebræ was cut away between the two nerves, leaving a ſmall portion as a holding part.

Exp. I. The prepared limbs being held by the portion of the vertebræ, the muſcular part of the thigh or knee was brought by the operator in contact with the nerves. Contractions inſtantly took place without any metallic communication.

Exp. II. Two prepared frogs were laid on the ſurface of a dry earthen plate, the oppoſite knees and the vertebræs communicating; as ſoon as a metallic arc was made by a bow of wire, touching the nerve and muſcle of one of the frogs, violent contractions took place in both.

Exp. III. Three prepared frogs were laid in the ſame order as in Exp. II, only the parts of the animal were not in contact, *except* by a ſtreak of water drawn by the finger from one to the other acroſs the plate. As ſoon as a metallic communication was made between the nerve and muſcle of one, all the three were thrown into motion, and at the ſame inſtant. If glaſs bars or metallic ones with a ſmall portion of wax on one end are uſed, no contractions are excited.

Exp. IV. A prepared frog being held by the foot and a portion of the vertebræ, and the other foot being brought in contact with a ſilver waiter, ſuch violent contractions were excited as to cauſe the limb apparently to leap along the plate.

Exp. V. The operator having hold of the feet of a prepared frog with one hand, and by wetted hands communicating with three perſons or more, the laſt perſon completed the circle by touching the vertebræ; in doing which contraction inſtantly took place.

Exp. VI. Two prepared frogs being laid in the order before mentioned on an earthen plate, a third was laid between them reverſed, the toes touching the vertebræ of the two. On a metallic communication being made, the two outward ones violently contracted, without any ſenſible effect on the middle one, though it ſerved as the conductor to one.

The ſecond ſeries was on a decapitated dog, in which the troughs were made by a flexible metallic conductor to communicate with the deſired part.

Exp. VII. A wire of tin communicating with one end of the trough being introduced into the rectum of the animal, the head being placed againſt the ſevered trunk, the communication

nication was made into the ear by a wetted wire, or flexible conductor, joining the oppofite end of the troughs. The contractions were fo violent as to throw the animal forward on the table.

Exp. VIII. The communications were exactly as in the laft experiment, but the head was feparated about fix inches from the trunk, and only communicated by the moifture on the table. On forming the circle, the contractions were nearly as before.

Exp. IX. The head being removed, the communication was made with the fpinal marrow; upon which the intercoftal mufcles were excited fufficiently to exfpire and infpire the atmofpheric air with fuch force, as to blow out a lighted taper.

Exp. X. Rabbits which had been decapitated exhibited feveral of the before-mentioned phænomena. Two trunks or two heads placed together experienced contractions on the communication being made.

Exp. XI. A portion of the diaphragm being laid on an earthen plate, was fubject to contraction on the communication being made.

Exp. XII. The heart was not fubject to contraction by the Galvanic fhock; but was affected mechanically, as it ufually is by glafs, refin, or any infulating pointed body.

Exp. XIII. Galvanic attraction was made fenfible by the operator holding a prepared frog by its feet, placing the other hand on the fpinal marrow of the dog, and bringing the fciatic nerves of the frog nearly in contact with the expofed ribs of the dog: the nerves were inftantly attracted, and contraction took place.

Exp. XIV. The contraction of the pupil of the eye, by connecting the optic nerve with one end of the pile and touching the iris with the other conductor, was fhown. This experiment was propofed by Mr. Babington.

The furgeons and pupils of Guy's and St. Thomas's Hofpital very handfomely prefented the profeffor with a gold medal*, as an acknowledgement of his attention and application in elucidating feveral of thefe compound experiments to their complete fatisfaction.

* On one fide are the arms of Guy's and St. Thomas's Hofpital; on the other is the following infcription, furrounded with raifed oak leaves:

Johanni Aldino,
Præclaro Phyfico,
Digno Galvani Nepoti,
Recens Experimentis commonftratis,
Profeffores et Scholares
Nofocom. St. Thomæ et Guy.
Libenter perfolvunt.
MDCCCIII. Londini.

The

The following account of fome experiments on a human fubject we copy from the newfpapers:

"The body of Forfter, who was executed on Monday the 17th of January for murder, was conveyed to a houfe not far diftant, where it was fubjected to the Galvanic procefs by profeffor Aldini, under the infpection of Mr. Keate, Mr. Carpue, and feveral other profeffional gentlemen. M. Aldini fhowed the eminent and fuperior powers of Galvanifm to be far beyond any other ftimulant in nature. On the firft application of the procefs to the face, the jaw of the deceafed criminal began to quiver, the adjoining mufcles were horribly contorted, and one eye was actually opened. In the fubfequent part of the procefs, the right hand was raifed and clenched, and the legs and thighs were fet in motion. It appeared to the uninformed part of the by-ftanders as if the wretched man was on the eve of being reftored to life. This, however, was impoffible, as feveral of his friends, who were under the fcaffold, had violently pulled his legs, in order to put a more fpeedy termination to his fufferings. The experiment, in fact, was of a better ufe and tendency. Its object was to fhow the excitability of the human frame, when this animal electricity is duly applied. In cafes of drowning or fuffocation, it promifes to be of the utmoft ufe, by reviving the action of the lungs, and thereby rekindling the expiring fpark of vitality. In cafes of apoplexy, or diforders of the head, it offers alfo moft encouraging profpects for the benefit of mankind. The profeffor, we underftand, has made ufe of Galvanifm alfo in feveral cafes of infanity, and with complete fuccefs. It is the opinion of the firft medical men, that this difcovery, if rightly managed and duly profecuted, cannot fail to be of great, and perhaps, as yet, unforefeen utility."

To render the preceding account more interefting, we fhall relate the following, either new, or not commonly known, facts.

1. Taking the ceffation of excitability to the Galvanic ftimulus as the criterion of life, the heart is not the *ultimum* but the *primum moriens*; for, while the mufcles of the limbs were excited to ftrong contractions for even 7 hours' apparent death by fufpenfion of a hot-blooded animal, the heart was utterly incapable of being excited to action, either by applying the extremity of the metallic arc to the furface or to the interior of this organ.

2. The lungs were equally inexcitable as the heart.

3. Not only were the mufcles, but the fkin and cellular membrane, excited to action by the Galvanic ftimulus.

4. The

4. The contractions of the mufcles were excited by the metallic arc or wire applied to the nerves fupplying fuch mufcles; but the nerves themfelves were not affected, not even the largeft nerve of the human body, the fciatic nerve.

5. Motion or raifing up of the arm was produced (as if by volition) by the Galvanic ftimulus.

6. A milky or coagulated matter was formed by repeated contractions of the mufcle in contact with the copper wire, or wire of copper plated with filver: and the fame appearance was feen when a plate of tin foil was interpofed, for then this white matter was formed on this tin foil.

7. When the parts ceafed to give out motion, or lefs motion, the motions were renewed with augmented force by wetting them with folution of fal-ammoniac.

8. It is fcarcely neceffary to remark, that the Galvanic ftimulus excited contractions in parts which gave out no action to fulphuric acid, volatile alkali, and other ftimuli.

Of the practical Ufes of Galvanifm.

The ufes in common life of new facts are not always immediately apprehended; fo that, although nothing very conclufive can be faid, the prefent facts may be hereafter of great utility. In the meanwhile we obferve:

1. That Galvanifm may be a moft powerful aid in reftoring the vital actions fufpended by fubmerfion, by fufpenfion, &c. although it does not act upon the lungs and heart; but if, at the fame time that it excites the mufcles in general, warm oxygen gas be applied to the lungs, and frictions and the hot bath be employed, much more may be effected than without Galvanifm.

2. In many difeafes confifting in ceffation of action, the parts may be excited to action by this new ftimulus, *if it be duly applied.* For this purpofe a machine is required which will of itfelf, without manual affiftance, apply effectually the Galvanic fluid for any length of time. Such an inftrument has been conftructed by Mr. Cuthbertfon, and will no doubt hereafter be as commonly ufed as our prefent electrical machines.

3. In comparing electricity to Galvanifm, it muft be confidered, that the former acts by its *intenfity,* and the latter by its *quantity:* that the former, fo intenfe, and fufficient if properly directed to knock a man down, fhall yet not be in *quantity* enough to melt an iron wire or one of platina; but the latter fhall melt thefe metals, yet fcarcely produce a fhock.

MISCEL-

MISCELLANEOUS.

1. Hildebrandt, in a ſeries of experiments on the action of both the carbonate and pure ammonia on copper, found no ſolution take place without the preſence of atmoſpheric air. Hahnemann had aſcribed the action to the carbonic acid obtained from the air, but this he has proved is without foundation. If the oxide of copper is uſed, a blue ſolution is produced without the admiſſion of the atmoſphere.

2. According to Vauquelin, the boracite called magneſio-calcareous borate by the French chemiſts, is not a triple compound, conſiſting of boracic acid, magneſia and lime. When tranſparent and cryſtallized, he finds in it none of the latter ſubſtance, but only boracic acid and magneſia. When opake, it is rendered ſo by lime, not in chemical combination.

3. An analyſis of the waters of Plombiers, by Vauquelin, gives per pint:

1 gr. 1-6th of ſulphurated ſoda.
5-8ths of muriated ſoda.
2-3ds of ſilex.
1-4th of carbonate of lime.
1 gr. 1-12th of carbonate of ſoda.
1-half of animal matter.

This animal matter is like albumen, and is only held in ſolution by the ſoda; as an acid inſtantly ſeparates it, and cauſes it to precipitate.

4. Brugnatelli recommends nitric ether to be prepared in the following way:—Into a tubulated retort put one ounce of ſugar and two ounces of alcohol: to the retort adapt a large receiver covered with wet cloths; ſecure the joint with paſted paper, then pour in three ounces of concentrated nitric acid by the tubulure: ebullition takes place, and an excellent ether of an orange colour paſſes into the receiver, which will not redden vegetable blues: as ſoon as the ether is all received, nitrous gas is evolved: the receiver muſt be immediately changed. By treating the reſiduary ſugar with more nitric acid, oxalic acid very pure will be obtained.

5. Mr. Dabit, in the *Annales de Chimie*, No. 127, gives an account of ſome experiments on the reſiduum of ſulphuric ether, from which he is induced to believe, that he has diſcovered an acid of ſulphur in a ſtate of oxygenation intermediate between the ſulphuric and ſulphureous acids. As yet he has not obtained it in a free ſtate; and he founds his

 concluſions

conclusions upon the phænomena presented by its saline compounds.

In saturating the residuum of ether, mixed with water, with carbonate of lime, he obtained a solution which gave by evaporation a salt that crystallized in parallelopipeds, having but little taste, and being soluble in 100 parts of cold water. This salt was decomposed by sulphuric acid. By the action of oxygen gas, or of nitrous acid, it was converted into sulphate of lime; and, by being heated with charcoal, it gave a sulphuret of lime.

When it was mixed with a solution of carbonate of potash, soda, or ammoniac, a double decomposition took place, and the stronger acid combined with the alkalies.

Mr. Dabit has noticed some of the properties of its alkaline combinations, which are extremely analogous to those of the sulphites. He proposes to call the acid the oxygenated sulphureous acid. But the application of the name will most probably be generally considered as premature; and new characters will be required to distinguish it from the sulphureous acid, before its existence as a peculiar body can be implicitly admitted.

6. Dr. Benzenberg, in an essay on the improvement of object glasses for telescopes*, warmly recommends that the glass be suffered to cool in the pots without stirring, and that the mass be then divided in a horizontal direction, so that the variation of density may be regular, and then, by a proper form of the glasses, the errors of refraction may be corrected. The idea is not new, but it does not appear to have been carried into practice. Dr. Benzenberg considers achromatic telescopes as promising much more than reflectors, and thinks that they intercept much less light.

7. Mr. Sprenger of Jever gives an account† of his method of administering Galvanic electricity in cases of deafness. A small ball is applied to the external orifice of the ear, and a much larger one is held in the patient's hand; the communication is then formed and interrupted alternately by means of machinery, once in every second, for about four minutes daily, for a fortnight or more. He asserts that he has thus restored the sense of hearing to forty-five persons, and to four of them that of smell also. All who were completely deaf experienced relief, almost without exception; but a partial deafness did not appear to receive the same benefit. The ear was filled with wool, to avoid taking cold. The degree of advantage obtained was estimated by an instrument invented

* Gilbert's Annals. † Ibid.

by

by Profeffor Wolke, in which a hammer falls from a certain point of a quadrant, fo as to ftrike an elaftic plate with a velocity capable of precife determination. Thefe experiments relate to a fubject fo important that they muft not be paffed unnoticed, however improbable it may appear that Galvanic electricity fhould have any material advantage over electricity otherwife excited, and however we may be difpofed to believe the report of other obfervers, that the relief is in general inconfiderable and only temporary.

ARTIFICIAL COLD.

Mr. Lowitz (*Journal de Chimie et de Phyfique*, by Van Mons,) concludes, from various experiments on artificial cold, of which a particular account is to be publifhed in the Tranfactions of the Academy of Peterfbourg,

1. That the principal caufe of the cold produced during the folution of falts in water, depends upon fome agency of their water of cryftallization; for falts deprived of this water, inftead of producing cold, produce heat.
2. Amongft the liquid acids, the muriatic acid is moft efficacious for forming freezing mixtures; the nitrous acid is next to it in order; and the fulphuric acid is leaft powerful.
3. The liquid acids produce cold only becaufe they occafion a quick folution of the fnow, or falt, of the freezing mixture.
4. Cauftic potafh and the muriate of lime furpafs very much, as cooling agents, the acids and the other faline fubftances.
5. The beft proportion of the mixture of fnow and muriate of lime, is two parts of the firft to three parts of the laft, mixed as accurately as poffible.
6. Five pounds of muriate of lime are fufficient to freeze thirty-five pounds of mercury.
7. The deliquefcent falts are much more proper for producing cold than the efflorefcent falts.
8. That the deliquefcent falts may produce the higheft poffible degree of cold, it is neceffary that they contain the greateft poffible quantity of water of cryftallization; and that they be ufed in fine powder.
9. The fnow employed fhould be that which has newly fallen, light and dry; and the experiments fhould be made at the commencement of a froft, and not during a thaw.
10. It appears that the fuperiority of the deliquefcent falts to the acids is owing to the circumftance of their be-

coming fluid at the same time that they cause the snow to dissolve.

11. Caustic potash and muriate of lime possess, amongst other advantages, that of being easily restored, unaltered, to their solid state, after an experiment, by evaporation.

PRESERVING ANIMAL SUBSTANCES.

Mr. Chaussier employs, for preserving animal matters from putrefaction, a solution of oxygenated muriate of mercury, kept constantly in a state of saturation. The preparations remain immersed in it for a certain number of days; and, after they are thoroughly impregnated with it, may be dried by exposure to light and air. After the process, they are no longer susceptible of being easily decomposed; they preserve their form, become possessed of a great degree of hardness, and are not subject to the attacks of insects.

HUMBOLDT'S TRAVELS.

The *Berlinische Monatschreft*, a journal published monthly at Berlin, contains an interesting extract of a letter from M. Alexander von Humboldt, in which he gives an account of the progress of his travels through South America. It is written from Contreras, near Ibagua in New Grenada. Before he left Carthagena he paid a visit to the forest of Turbaco, celebrated for the size of its trees: some of them are eight feet in diameter, and are of the kind named *cavanillesia mocondo*, before observed by Jacquin, who travelled in the time of Francis I. M. von Humboldt, who had proposed to go to Peru, could not resist the desire he entertained of proceeding to Santa-Fé-de-Bajota to see the celebrated botanist Mutis, 72 years of age, and one of the friends of Linnæus.

Thus, instead of proceeding by sea to Guayaquil, which was much more convenient, he pursued the route to Quito by land through Santa-Fé. He first navigated, for forty-five days, along the river De la Madelaine, amidst the most dreadful tempests and the most dangerous cataracts. During this part of his journey he constructed a topographical chart of the country on four folio sheets, a copy of which was kept by the viceroy. When he arrived at Honda, in five degrees north latitude, he visited the mines of Mariquita and Sainte-Anne. In that country he found considerable plantations of cinnamon and nutmeg-trees; and whole forests of the tree which furnishes cinchona, and of the almond-tree, called by botanists *caryocar amygdaliferum*.

M. von Humboldt was at that time accompanied by a young

young Frenchman named Desieux, to whom the Spanish government had entrusted the care of these plantations. Our travellers at length reached the entrance of the Cordilleras (*la Bocca del Monte*), climbed up the first eminences, and came to the plain of Bajota, one of the highest of the globe. This plain was formerly a lake, containing a surface of 32 square leagues: in the middle of it is situated the town of Santa-Fé. M. von Humboldt was received here as if in triumph: sixty persons on horseback came to meet him; and the venerable Mutis had prepared a house for him near to his own. The king of Spain devotes 10,000 piastres per annum to this botanical establishment. For fifteen years past, thirty draftsmen have been employed in it under the direction of Mutis. They have executed 3000 drawings in folio, which are finished with all the delicacy of miniature painting. M. von Humboldt could compare the botanical collection of Don J. Celestino Mutis only to that of Sir Joseph Banks. M. von Humboldt measured the altitude of the mountains which surround Santa-Fé, several of which rise to the height of 2000 and 2400 toises. From Santa-Fé he was to proceed to Quito, and thence to Lima. He was to be at Acapulco in the month of May last year, and, after travelling through Mexico, he was to return to Europe by the Philippines and the Cape of Good Hope. Such a journey, undertaken by so enlightened a man, promises the happiest results to science.

SALTS OF IRON*.

The sulphate, muriate, and acetite of iron, at their minimum of oxidation, may be obtained in a very easy manner by means of the artificial sulphuret of iron. When artificial sulphuret of iron is acted upon by muriatic acid, or sulphuric acid in a state of dilution, or acetous acid, the sulphureted hydrogen gas, disengaged during the process of solution, prevents any hyper-oxygenated salt from being formed by the action of the atmosphere; and a clear fluid, in all cases, of a shade of green, is obtained, which, when freed by heat from any sulphureted hydrogen dissolved in it, gives a perfectly white precipitate with the alkaline prussiates, and is not found to alter the colour of solution of galls.

To form the least oxygenated nitrate of iron, by means of the artificial sulphuret, an acid of a specific gravity not greater than 1·12 must be used; and the solution must be made without the assistance of heat. After having been freed from sulphurated hydrogen, by being boiled for a minute or two, and

* From *Journals of the Royal Institution of Great Britain.*

then filtrated, it is found ſimilar in its colour and phyſical properties to the weakeſt ſolutions of the other oxygenated ſalts.

When the ſulphate and muriate of iron, at the minimum of oxidation, are obtained in the ſolid form, by evaporation from their ſolutions, they appear in regular cryſtals, which in each ſalt are a different ſhade of a very pale green colour; their taſtes are exactly ſimilar, being aſtringent, and leaving in the mouth the ſenſation of ſweetneſs.

The leaſt oxygenated nitrate of iron cannot eaſily be procured pure in the cryſtallized ſtate; for when the ſolution of it is heated for any length of time, a new arrangement of its principles takes place; portions of the acid and of the water of the ſolution are decompoſed; in conſequence of which ammoniac is formed; and an oxygenated nitrate of iron, with exceſs of baſe, is depoſited.

Amongſt the ſalts of iron, at the minimum of oxidation, I have found the muriate the moſt convenient for exhibiting the experiments of Prouſt, and in eudiometrical proceſſes with nitrous gas. It is more ſoluble in water than the ſulphate, and very much more ſoluble in alcohol. D.

ERRATUM.

Page 82, lines 3 and 4, for " organ of inſtinct *and*," read " organ of inſtinct *of*."

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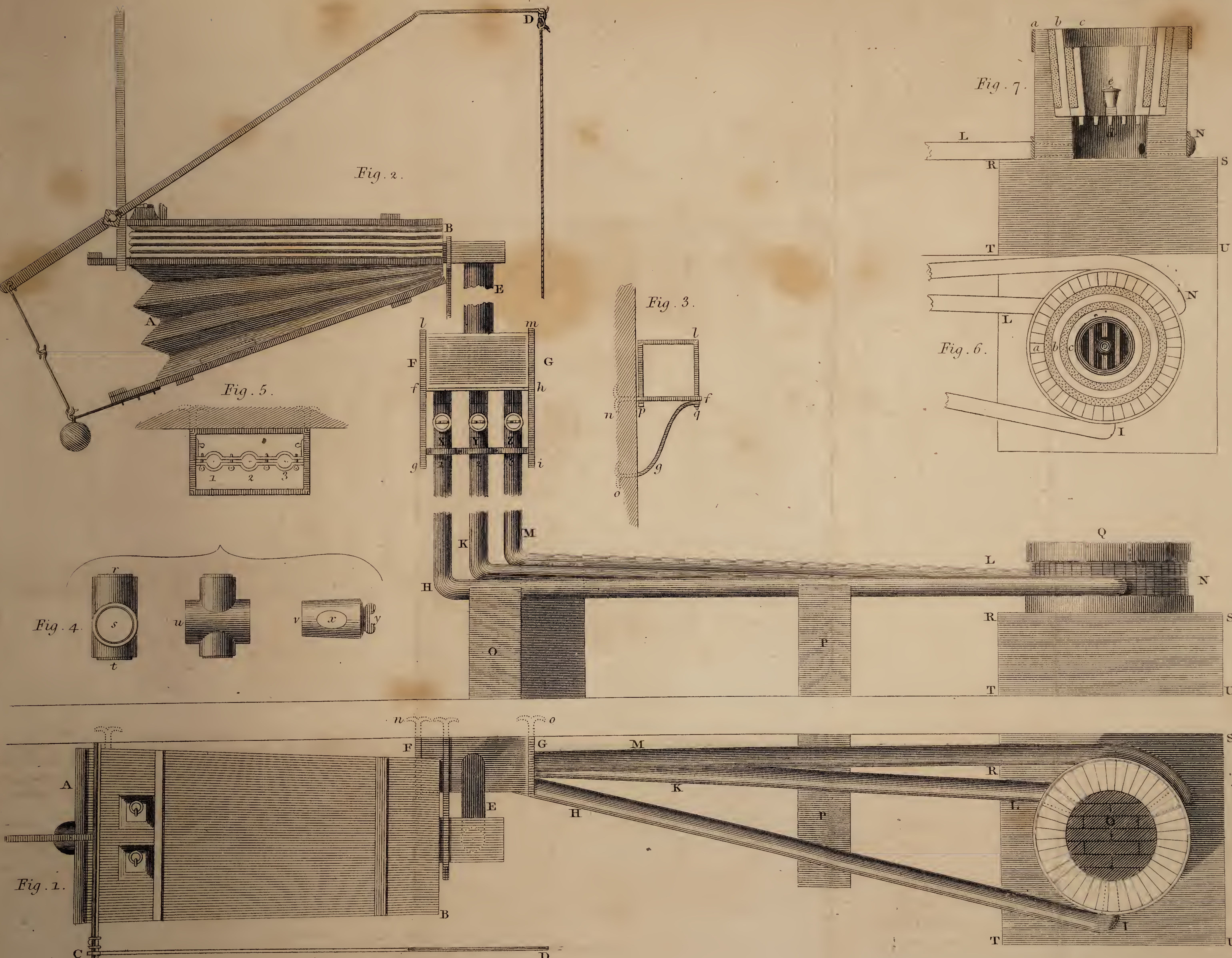

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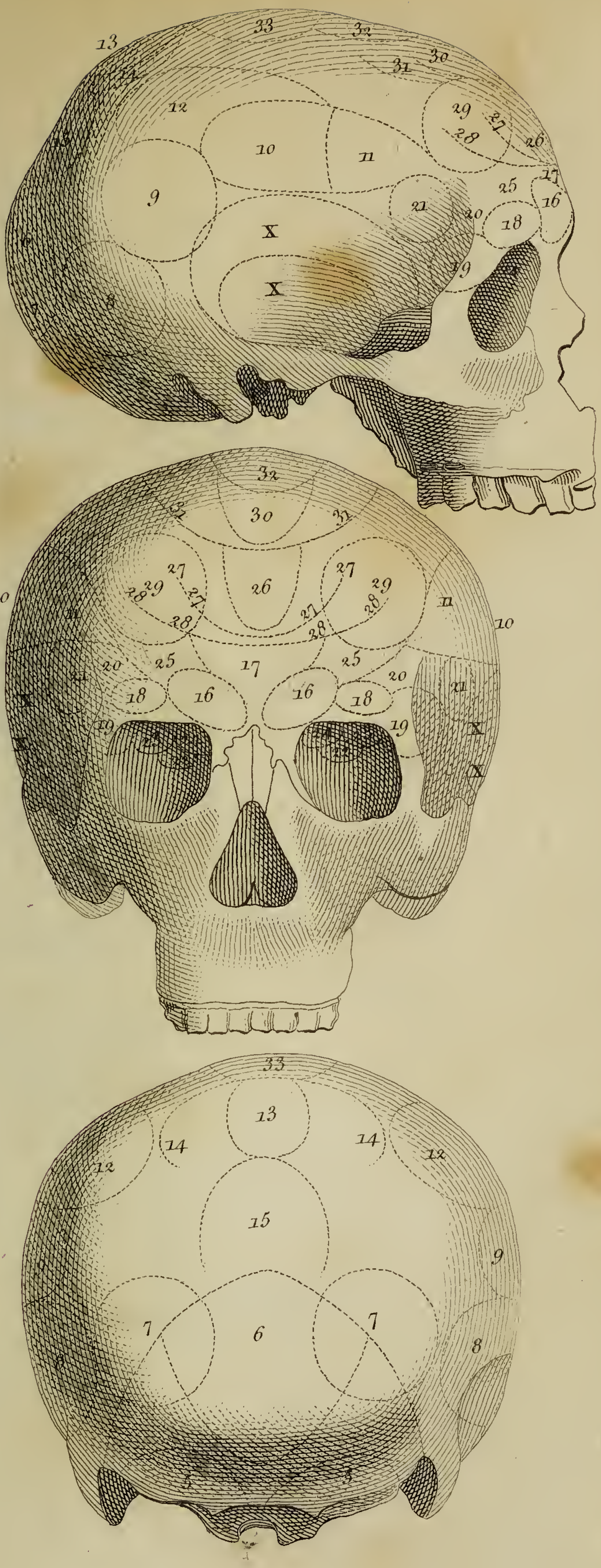
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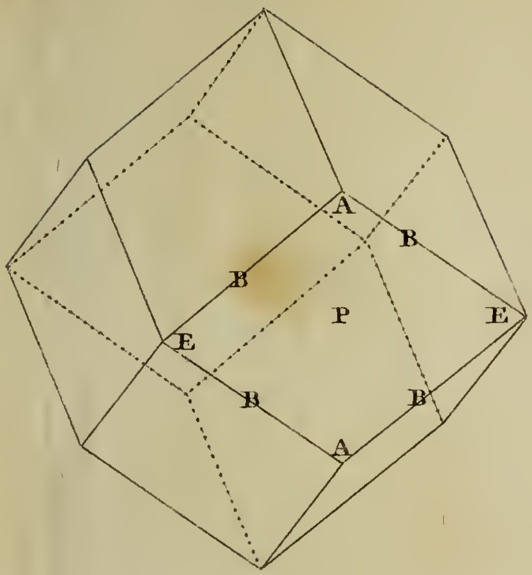

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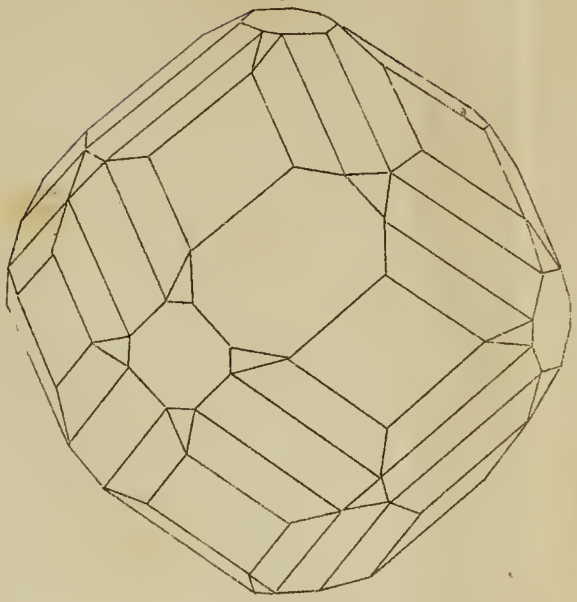

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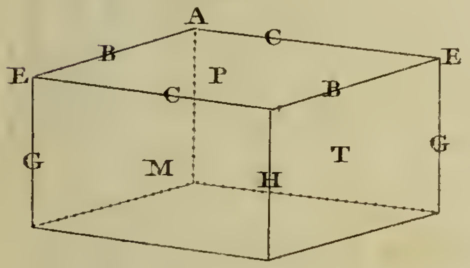

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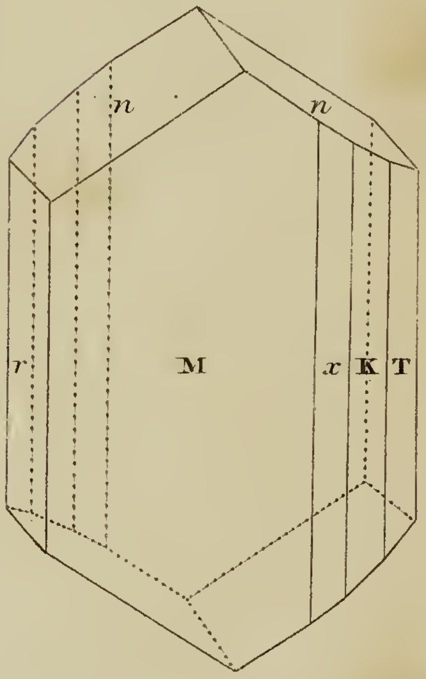

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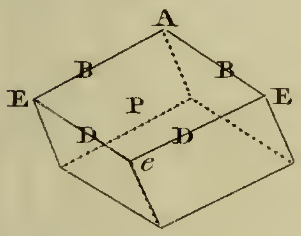

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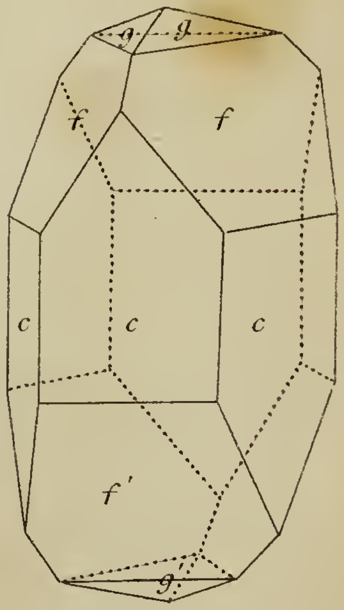

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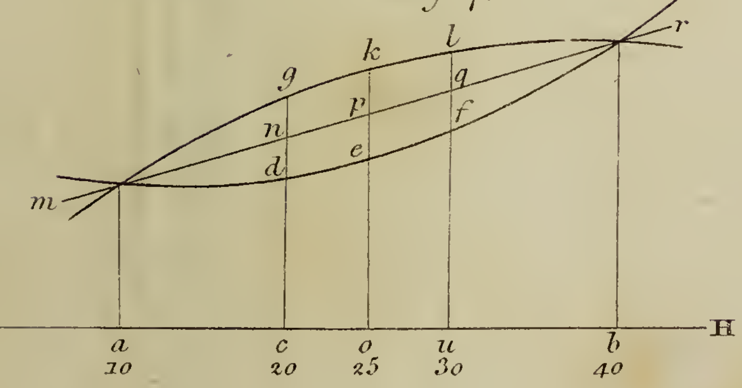

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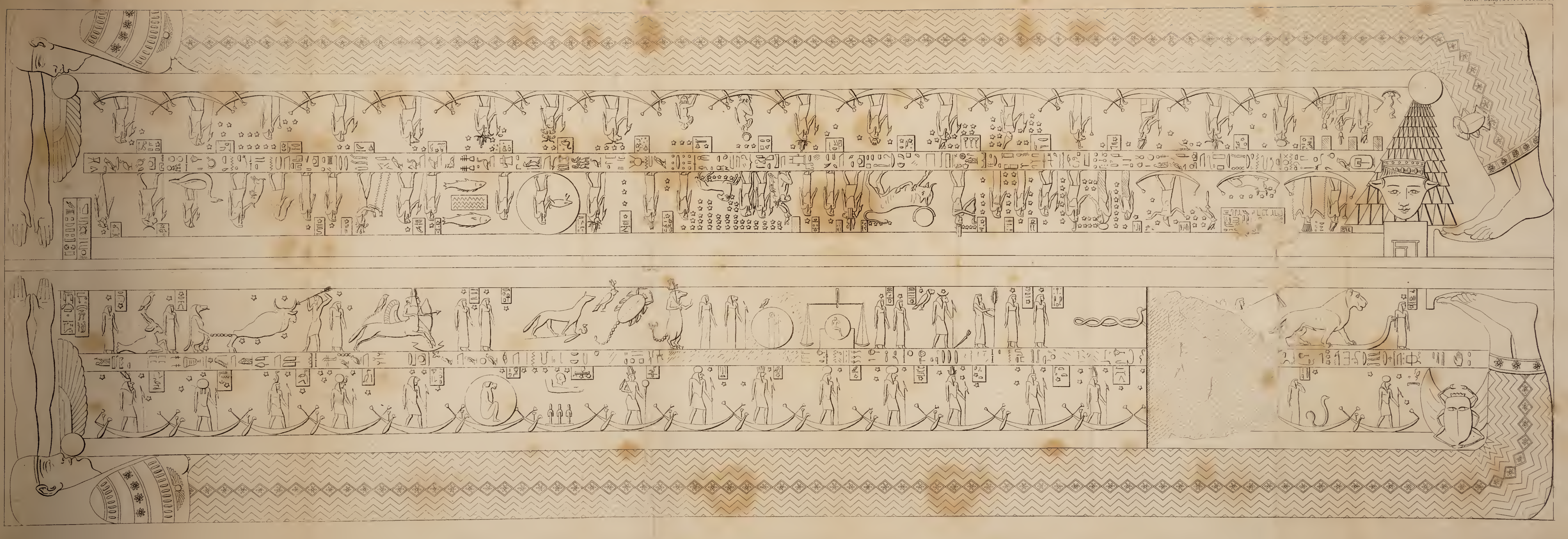

Head of the Mammoth.

Head of the Elephant.

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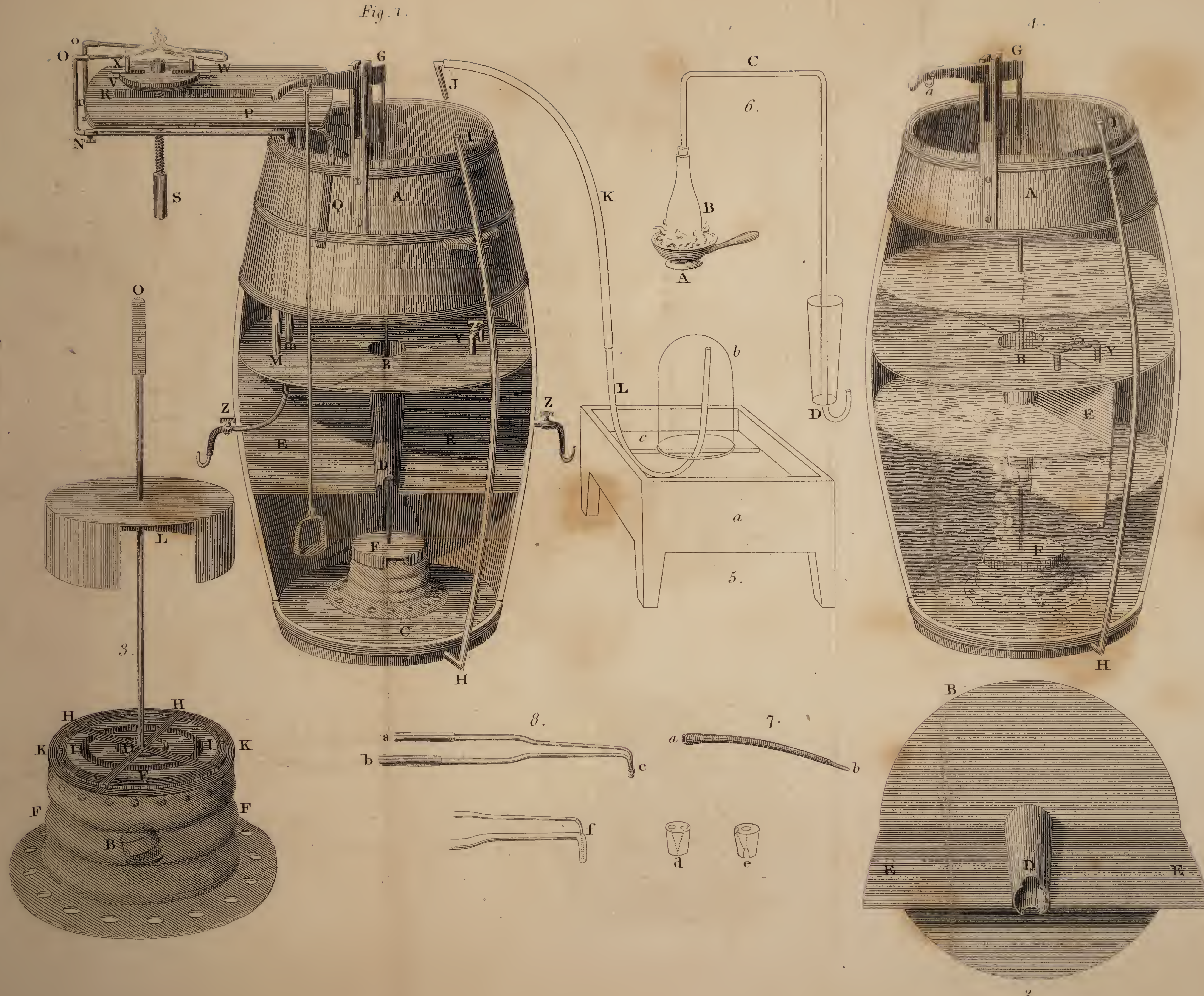
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Lowry sculp

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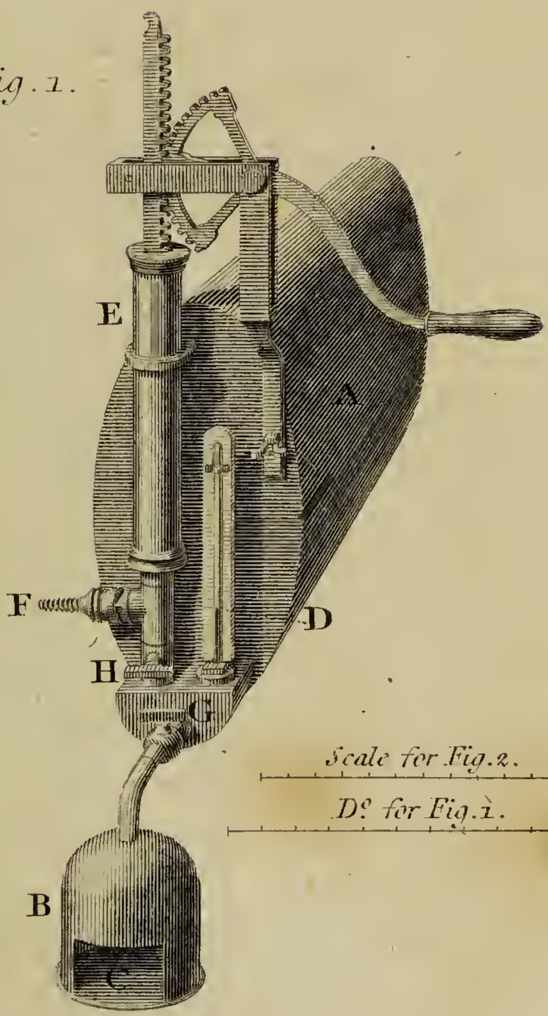

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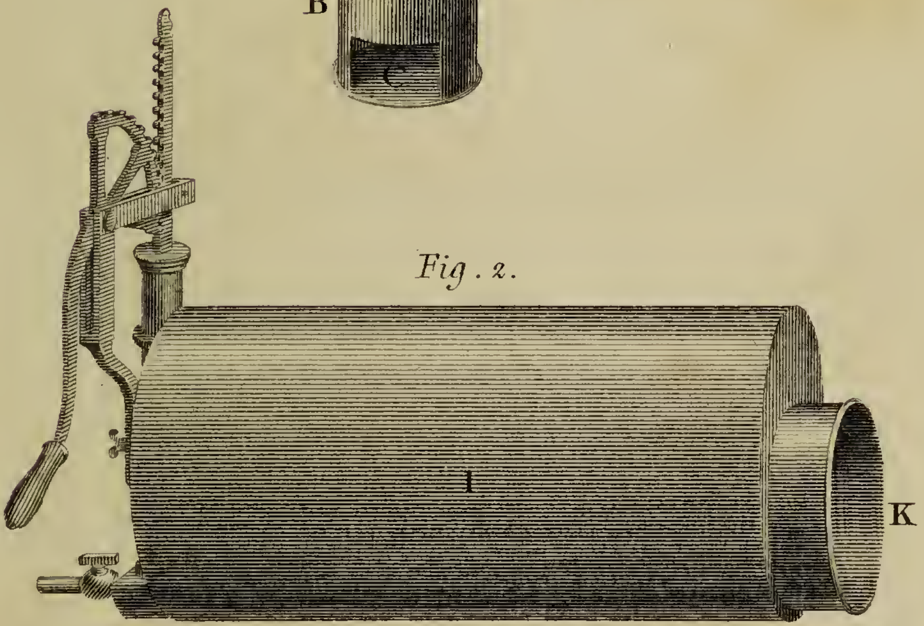

Matilda Lowry del. W. Lowry sc.